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GROUNDWATER IN THE BARKLY TABLELAND NORTHERN TERRITORY

Volume 1

by

M. A. Randal

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GROUNDWATER IN THE BARKLY TABLELAND

SUMMARY

This report deals with the groundwater resources of the central and eastern part of the Barkly Tableland in the Northern Territory of Australia. The Tableland, which contains some of the best cattle breeding country in Australia, lies between the Queensland town of Camooweal to the east, the mining township of Tennant Creek to the west, and the headwaters of streams flowing into the Gulf of Carpentaria to the north; the southern boundary is conveniently taken as the Barkly Highway in the west, and the valleys of the Ranken and Georgina River in the east. Only the part of the Tableland between the Queensland border in the east and Tarrabool Lake in the west is discussed in this report (Fig. 1).

Because of the high evaporation (100-110 inches per annum), the low and seasonal rainfall, and the low relief in the downs country, there is insufficient surface water during the dry season to sustain the cattle industry, which must therefore rely on groundwater. Consequently over 450 water-bores have been drilled in this region since 1890, and the data from them were examined to assist the geological mapping of the Tableland, an area of very sparse outcrop.

Proterozoic rocks crop out in the northern and north-eastern part of the region (Dunn, Smith, & Roberts, in prep), but of these only the youngest unit - the Mittiebah Sandstone - appears to be involved in the groundwater system; and then only in a small way. The greater part of the region is occupied by Middle Cambrian rocks, which form part of a widespread, mainly carbonate, sequence which occurs over the Barkly Tableland and adjoining parts of the Northern Territory and Queensland (Opik, 1956a, b). Mesozoic and Tertiary rocks overlie the Cambrian sequence (Pl. 1), but in the region under review they have no direct bearing on the groundwater system, as they are too thin and restricted for the storage of adequate amounts of water.

The Cambrian rocks consist of dolomite, dolomitic limestone, limestone, leached carbonate rocks, chert, sandstone, and siltstone. Water is stored under pressure in fissures, cavities, and fractures in the carbonate rocks, and in porous sandstones.

Drillers' logs record up to four aquifers in some bores, but it has not been possible to correlate aquifers because of the inadequate rock descriptions

SUMMARY (cont)

in the logs and the meagre stratigraphic knowledge of the region. However it has been possible to broadly define the configuration of the aquifer system: its surface ranges from 15 feet to 600 feet above sea level in the north-western part of the region and from sea-level to 600 feet in the south-eastern part.

The groundwater system contains two areas of characteristic hydraulic gradients as indicated by the piezometric surface. One area approximately coincides with the internal drainage basin occupied by the swamps between Alroy Downs and Anthony Lagoon Homesteads; here the piezometric surface, which ranges from 530 to 750 feet above sea-level, indicates semi-stagnant conditions with restricted flow out of the basin to the north-west and west. In the second area, the piezometric surface, which ranges from 530 to 650 feet above sea-level, indicates the groundwater flows generally southwards; this groundwater basin is generally co-extensive with the surface drainage of the Georgina River Basin.

More than 75 percent of the working bores produce more than 1500 gallons per hour, and most produce more than 1000 gallons per hour, but inadequate testing has probably under-estimated the full potential of many bores. The permeability of the aquifers cannot be adequately appraised from the supply and draw-down characteristics of the bores as they have not been systematically recorded. The relationships between the withdrawal of groundwater, the annual rainfall, and probable intake areas indicate that considerable groundwater reserves are available for the future development of the region.

The quality of the groundwater is extremely variable, but in most instances it is suitable for stock. In the groundwater system coincident with the internal drainage basin in the central part of the region, the general high salinity makes most of the water unsuitable for human consumption. The variations in the total salinity agree with the general directions of groundwater flow.

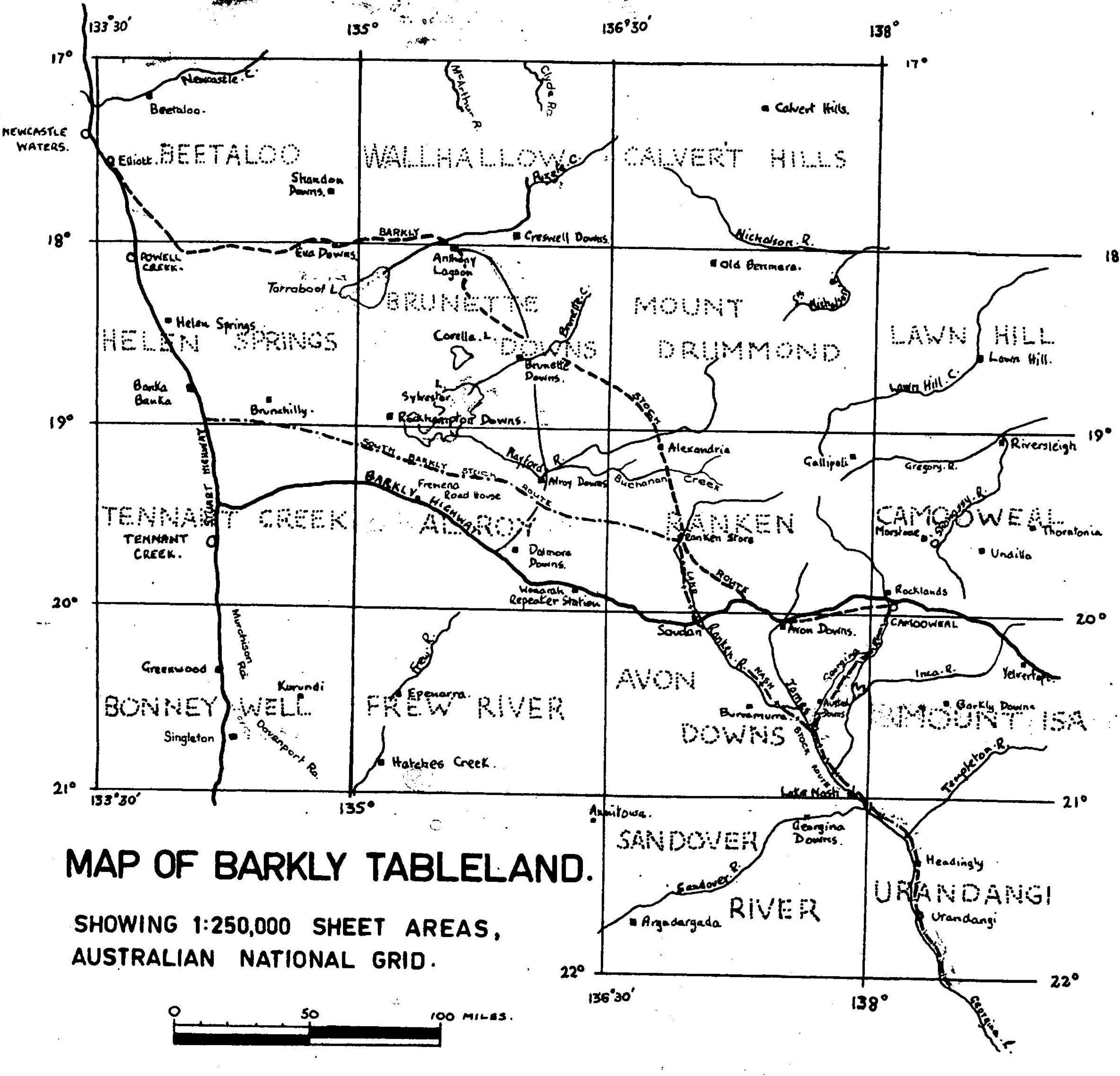
The regional geochemistry of the groundwater has been evaluated from 265 bore-water samples, and the results used to determine the groundwater environment in relation to hydraulics and geological structure. The bore-waters have been analysed for sodium, potassium, magnesium, calcium, chloride, sulphate, bicarbonate, carbonate, fluoride, silica, total dissolved solids, specific

SUMMARY (cont)

conductivity, and pH; in addition about half the samples were analysed for nitrate, nitrite, phosphate, manganese, iron, aluminium, boron, lead, strontium, and lithium. The waters have been classified into groups and types on the basis of the dominant anions i.e. chloride, sulphate, and bicarbonate. Maps of the geochemical water types and contour maps of the absolute ionic concentrations and the ionic ratios support the division of the region into two groundwater provinces, and also suggest lithological and structural control of the geochemical types. Until a more detailed knowledge of groundwater flow and its effect on the geochemistry is obtained, only a limited geological interpretation can be made.

Some results of the survey are of immediate benefit: for proposed bores the depth to adequate supplies can be estimated, the probable pump position calculated, and some estimate of supply given; in addition the total salinity and the concentration of individual constituents can be predicted within close limits. Furthermore the survey has shown the need for further intensive study before the bore-waters are used for agriculture on the clayey black soil as some are rich in sodium. Recommendations are made for further investigation - the more important of these are: accurate drilling records, geological examination of rock-chips from water-bores, accurate levelling of bore-sites, construction of observation wells, and the use of radioactive tracers.

FIG. 1.



MAP OF BARKLY TABLELAND.

SHOWING 1:250,000 SHEET AREAS,
AUSTRALIAN NATIONAL GRID.

Bureau of Mineral Resources, Geology & Geophysics. April, 1962

To accompany Records 1962/49, 55, 56, 61. 1966/11.

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INTRODUCTION

This report deals with the groundwater resources of the central and eastern parts of the Barkly Tableland from the Queensland/Northern Territory border westward to Tarrabool Lake and Rockhampton Downs Homestead. This region[+], which comprises the Wallhallow, Brunette Downs, Alroy, Mount Drummond, Ranken, and Avon Downs 1:250,000 Sheet areas, is bounded in the north by the headwaters of the McArthur, Clyde, and Nicholson Rivers; it is bounded in the south by the semi-desert area which extends from near Tennant Creek east-south-eastwards to a few miles west of Lake Nash Homestead (Fig. 1). The region is served by the townships of Camooweal, eight miles to the east on the Barkly Highway, and Tennant Creek, 70 miles to the west on the Stuart Highway. The Barkly Highway, which is bitumen-sealed, connects Mount Isa to Tennant Creek via Camooweal, and provides access to numerous station tracks and stock routes.

The eastern and central parts of the Barkly Tableland are traversed by four major stock routes: the Barkly Stock Route from Camooweal to Newcastle Waters (Elliott), the South Barkly Stock Route from Ranken Store to Attack Creek on the Stuart Highway, the Lake Nash Stock Route from Ranken Store to Lake Nash Homestead via Soudan Homestead, and a stock route which follows the Georgina River from Camooweal to Urandangi via Lake Nash Homestead; minor stock routes provide outlets for stations not directly linked by these. In addition a new road has been constructed from the Barkly Highway near Dalmore Downs Homestead to Anthony Lagoon Homestead via Alroy Downs and Brunette Downs Homesteads. Police stations are situated near Anthony Lagoon, Lake Nash, and Avon Downs Homesteads.

Twelve cattle stations occupy the region - Anthony Lagoon, Creswell Downs (including Wallhallow), Brunette Downs, Rockhampton Downs, Alroy Downs, Dalmore Downs, Alexandria Downs (including Gallipoli and Soudan), Austral Downs (including Burramurra), Avon Downs, and portions of Georgina Downs, Lake Nash, and Rocklands. Rocklands Homestead lies east of the region near Camooweal, and Georgina Downs Homestead is south-west of Lake Nash Homestead (Fig. 1).

[+] Unless otherwise qualified, the word 'region' in this report refers to the combined area of these six sheet areas.

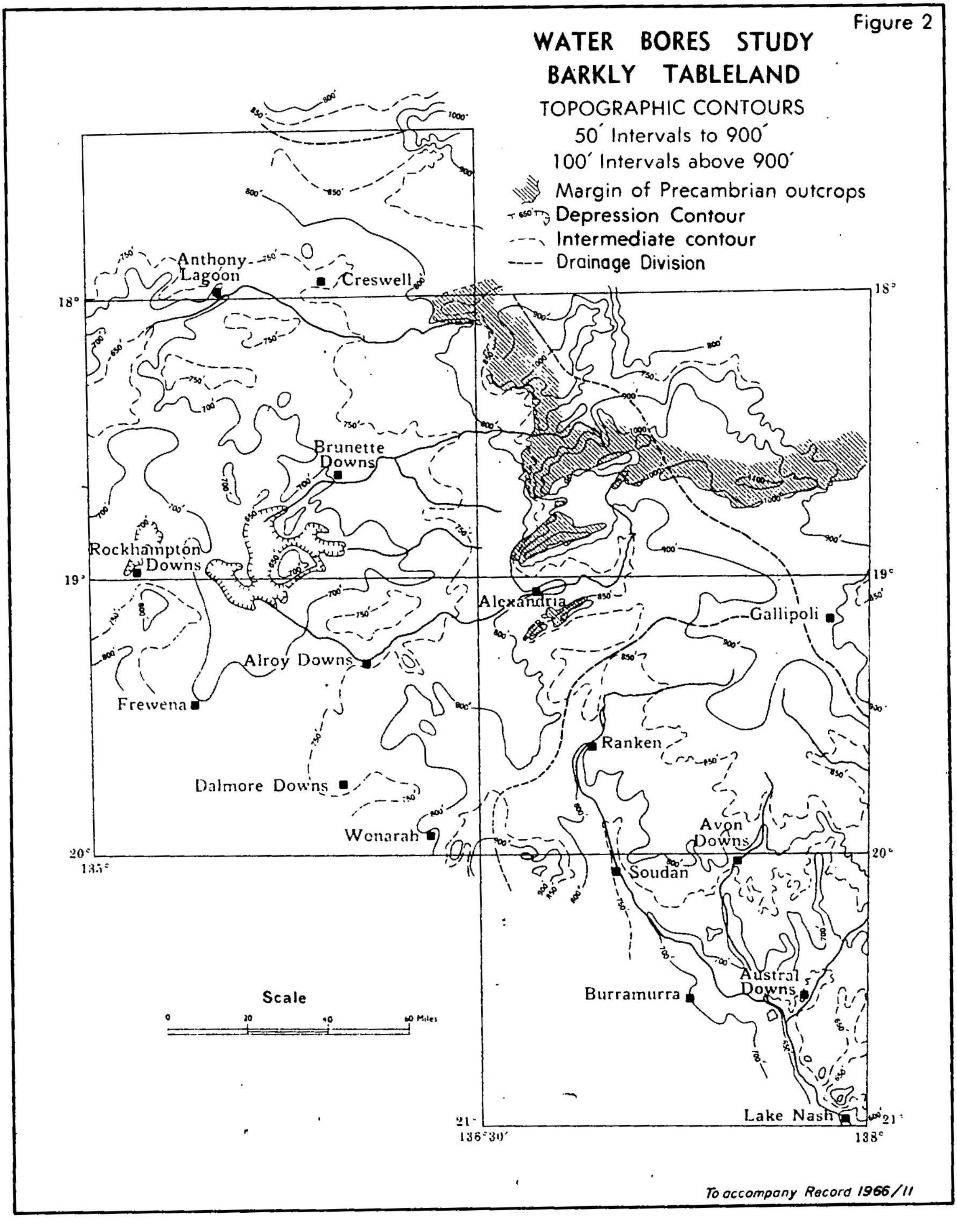
Wonarah Repeater Station and Frewena Roadhouse are on the Barkly Highway in the west of the region; a store is situated on the Ranken River between Soudan Homestead and Alexandria Homestead. Most homesteads are connected by the outpost radio network to the Royal Flying Doctor Base at Alice Springs; Lake Nash, Avon Downs, Austral Downs, Soudan, Wonarah, and Frewena have a telephone service.

PHYSIOGRAPHY

It is difficult to define the Barkly Tableland as a physiographic entity. Most maps of the Northern Territory show the Tableland extending from about the Queensland-Northern Territory border to near Newcastle Waters, and bounded on the north by a north-facing escarpment, but the southern margin is not clearly defined. Only on the northern and part of the north-eastern margins does the region have the aspect of a Tableland. The western margin is regarded loosely as the Stuart Highway, which however follows no natural boundary of land form except the high ridges from Elliott to Tennant Creek in the south-west. The region is adjoined in the south-west and central west by a large area of semi-desert of higher elevation than the Tableland, and which lies adjacent to the ridges of the Davenport and Murchison Ranges. The demarcation of a south-eastern margin to the Tableland also presents problems. There the rolling downs of the Georgina River Basin are contiguous with those of the Tableland north of the Barkly Highway and no physiographic boundary is readily apparent. A similar problem exists east of the Queensland-Northern Territory border where the northern escarpment merges with the canyon topography north of Camooweal, and is not apparent east of Camooweal. However, this part of the Tableland is not considered in this report.

Noakes (1954) regards the term 'Tableland', as applied to the region, a misnomer and describes the Barkly Tableland as 'a long shallow depression which forms part of two of the three physiographic units into which the Barkly Region has been divided - the Barkly Internal Drainage Basin and the Georgina Valley'. C.S.I.R.O. (1954) described the Barkly Region as 'the area popularly known as the Barkly Tableland, a contiguous portion of the Georgina River basin and the inland "desert", and the country extending to the Gulf of Carpentaria'. In the same report the Barkly Region has been divided into three geomorphological divisions - Gulf Fall, Georgina Basin, and the Barkly

Figure 2



WATER BORES STUDY BARKLY TABLELAND

TOPOGRAPHIC CONTOURS

50′ Intervals to 900′

100′ Intervals above 900′

To accompany Record 1966/11

Basin; the boundaries of these divisions in the south-east and east clearly cut across the indistinct boundaries of the so-called Tableland. These geomorphological divisions have been followed in this report, but Noakes' (op. cit) term Barkly Internal Drainage Basin is preferred and used in this report.[+] Their extent is illustrated by the surface contours (Pl. 2; and Fig. 2).

The north-western boundary of the Barkly Tableland is ill-defined. The north-facing scarp which forms the northern margin swings north-westwards near the headwaters of Newcastle Creek and is well-defined to east of Mataranka. The country west of this scarp is identical to much of the northern part of the Barkly Tableland further east. This aspect has been recognized by Dunn, Smith, & Roberts (in prep.) who describe a physiographic division known as the Barkly-Birdum Tableland. Such a division is certainly valid in the northern and north-western parts of the region as it coincides with and is an extension of the northern boundary of the Barkly Internal Drainage Basin; also the country south of the scarp is underlain by mainly sub-horizontal Mesozoic and Cambrian rocks and presents a very different land-form to the folded and faulted Precambrian rocks of the hilly and dissected Gulf Fall Division to the north. However Smith & Roberts (1963) extend the division on to the Mount Drummond Sheet area where in the eastern part it transgresses the divisions based on drainage: this is justified on the grounds of geology and landform.

The Georgina River Basin, which includes the Georgina, Ranken, and James Rivers, occupies the south-eastern part of the region, and contains the downs country east of Soudan Homestead. The downs consist of clayey, black soil which supports a good growth of Mitchell grass and some swamp Flinders grass. Low stony and sandy rises are common, and red clayey soil occurs in small patches; the sandy and red soils support small areas of mallee and turpentine scrub. Gidyea scrub is widespread in the north-eastern part and along the watercourses; some stands of eucalypts occur near permanent and semi-permanent waterholes; bluebush swamps are common, but not numerous. The

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[+] It emphasises the nature of the unit, and avoids confusion with the so-called Barkly Basin shown on some geological maps as the connecting link between the Daly River Basin and the Georgina Basin, which are both geological features containing Lower Palaeozoic sediments. For the same reasons the term Georgina River Basin is used in this report.

watercourses are generally confined to single, well-defined channels, but in places the larger streams are braided, particularly the Georgina River north of Austral Downs Homestead. Near the headwaters the streams are poorly-defined and are low, barely discernible depressions in the monotonous and uniform grassy downs; in the south-east the streams have well-defined but shallow valley profiles.

The divide between the Georgina River Basin and the Barkly Internal Drainage Basin is well defined though low north-west of Soudan, but in the semi-desert area to the south it is non-existent, and the division is arbitrary. The divide between the Georgina River and the Gregory River of the Gulf Fall Division occurs in the elevated downs country south of Gallipoli Homestead.

The Gulf Fall Division occupies two areas in the region - one in the north-east and one in the north-west. The two areas are linked on the Calvert Hills Sheet area, which is not included in this survey.

The first area is drained by the Gregory, Nicholson, and South Nicholson Rivers (Plate 2). With the exception of Buddycurrawa Creek, which traverses mainly sand-covered plains, the major streams rise in low ranges, and flow through dissected country of dominantly Precambrian rocks. The headwaters are well developed stony gullies; soils are mainly skeletal and in part lateritic, and support various eucalypt trees and shrubs. However in the south-east the streams drain part of the Barkly Tableland. The Gregory River, and Carrara Creek, rise in gently undulating downs country and in their upper reaches are barely discernible; but to the east of the area they form part of a large area of well-developed canyon topography (Opik, Carter, & Randal, in prep.) in Middle Cambrian carbonate rocks.

The north-western area of the Gulf Fall Division contains the upper reaches of the McArthur, Kilgour, and Clyde Rivers. The southern boundary is the north-facing scarp of the Barkly Tableland. The streams play only a minor role in the drainage of the Tableland which here slopes slightly to the south. Plumb & Rhodes (1964) have divided the Gulf Fall of this area into the Dissected Gulf Fall, the Bukalara Plateau, and the Top Springs Erosion Surface; the latter unit adjoins the Tableland. The entire area is moderately dissected - gently undulating and steeply undulating plains and hillocks merge into hilly country in the north. The streams are everywhere well entrenched and contain steep rocky gullies in their headwaters. Vegetation is mainly snappy gum, silver box and bloodwood on the slopes, lancewood and bloodwood on the plains, and coolibah and paper-bark along the valleys. Some Mitchell and blue grasses occur on the more open plains, particularly around the Kilgour River.

The Barkly Internal Drainage Basin occupies the western part of the region; it is the largest physiographic division of the Barkly Tableland. This Drainage Basin is not a single entity; it consists of a number of bluebush swamps or lakes which are themselves internal drainage centres. The largest of these is Lake Sylvester (including Lake De Burgh) which occupies the centre of the Basin, and in the wet season receives water from a large area in the central part of the region. This area is drained by Brunette, Fish Hole, and Mittiebah Creeks, Boree Creek, and the Playford River and its tributaries Buchanan and Desert Creeks; the main streams join Lake Sylvester as deltas and long lagoons.

The next largest drainage centre is Tarrabool Lake in the north-west which receives water from Creswell and Puzzle Creeks and from minor streams. Corella Lake also in the central part of the Basin, is fed by Corella and Edwards Creeks. As well as the major lakes, smaller bluebush swamps and claypans occur south of the Playford River, between the Playford River and Boree Creek, north of Creswell Creek, and west of Lake Sylvester. These act as foci for small gullies and runnels during brief periods of local seasonal flooding. In the south of the region the Frew River, which rises in the Davenport Ranges (Fig. 1), empties into a local internal drainage claypan or swamp.

The streams in the area are braided in their lower courses and have broad shallow valley profiles; in the upper reaches they are well-entrenched with sharp though not deep valleys. The major streams rise in the ridges in the western part of the Mount Drummond 1:250,000 Sheet area. Smith & Roberts (1963) refer to these ridges as the Mittiebah Uplands. Streams which rise in the grassy downs are barely discernible in their upper reaches.

The Barkly Internal Drainage Basin includes an area south of the Barkly Highway which has a different vegetation and topography to the northern part of the Basin. The area is part of a semi-desert which contains the internal drainage of streams flowing northwards off the Davenport Ranges.

The area is conveniently included in the Barkly Internal Drainage Basin; this conforms with the divisions of Stewart (1954a).

The Barkly Internal Drainage Basin contains some of the land systems used by Stewart et al (1954); they have characteristic landforms and vegetation which are summarized in Randal & Nichols (1964). The dominant land system is the rolling black-soil downs; it is essentially a grassland with various types of Mitchell grass dominant over Flinders, couch, and blue grasses. The topography is gently undulating with low gravelly rises supporting various species of eucalypts and acacias, which also occur along the watercourses. The drainage is well developed and dendritic; however major watercourses are widely spaced owing to the low run-off. The downs country occurs mainly on carbonate rocks of Cambrian and Tertiary ages.

The downs country is adjoined on the west and south by timbered areas which separate it from the semi-desert area of mallee scrub and Acacia spp. Vegetation consists mainly of box and bloodwood associated with sparse shrubs and grasses, but west of the lakes coolibah with Acacia spp., together with bluebush, blue grass, and occasional Mitchell and Flinders grasses occur.

Surface elevations have been contoured with the aid of barometric spot heights obtained by the Division of National Mapping and supplemented by the Bureau of Mineral Resources (Fig. 2).

GEOLOGY

The geology of the entire region (Pl. 1) has been mapped at 1:250,000 scale by the Bureau of Mineral Resources. Private oil companies have carried out some supplementary surface and subsurface investigations. The Wallhallow Sheet area (Plumb & Rhodes, 1964) and the Mount Drummond Sheet area (Smith & Roberts, 1963) were mapped during the investigations of the Carpentaria Proterozoic Province; the Ranken and Avon Downs Sheet areas (Randal & Brown, 1962a and b) and the Brunette Downs and Alroy Sheet areas (Randal & Nichols, 1963) were mapped as part of the regional mapping of the Georgina Basin. In 1962, the Bureau of Mineral Resources carried out a coring programme in the Georgina Basin (Milligan, 1963); four of these holes - Grg 15, 15a, 16, and 17 - were drilled in the central southern part of the region.

Precambrian rocks crop out in the north-western and north-eastern parts of the region; these rocks form part of the Carpentaria Proterozoic Province which extends from the Queensland/Northern Territory border north-westwards to

TABLE 1. - STRATIGRAPHY OF THE BARKLY TABLELAND

AGE		ROCK UNIT & SYMBOL	LITHOLOGY	THICKNESS	DISTRIBUTION	FOSSILS	STRATIGRAPHIC RELATIONSHIP
CAINOZOIC		Superficial deposits Cza Czb Czs Czl Czt	 Alluvium Clayey soils Sand Laterite Travertine	50 ft	Widespread over region		
	TERTIARY	Cleanskin Beds Tl	Chalcedonic limestone, chert	50 ft			Post-Mesozoic
		Austral Downs Limestone (Ta)	Limestone, siliceous limestone, some dolomite. Chert nodules, sandy lenses	45 ft +	Avon Downs Sheet area		Unconformably overlies Cambrian rocks
		Brunette Limestone (Tb)	as above	60 ft +	Brunette Downs, Ranken, and Wallhallow Sheet areas	Marine microfauna, freshwater pelecypods and gastropods	as above
MESOZOIC		M	Sandstone, pebbly conglomerate	unknown	Ranken and Avon Downs Sheet areas	Plant remains	No contacts, but presumably unconformably overlies Cambrian rocks
	LOWER CRETACEOUS	Kl	Mudstone, sandstone, siltstone, conglomerate	200 ft	Wallhallow and Mount Drummond Sheet area	Plant remains, marine microfauna	Unconformably overlies all older rocks
CAMBRIAN	UPPER CAMBRIAN	Meeta Beds (Єum)	Dolomite and sandstone	1000 ft +	Southern part of Avon Downs Sheet area	Gastropods	Apparently overlies Camooweal Dolomite
	MIDDLE CAMBRIAN	Border Waterhole Formation Currant Bush Limestone	Limestone, chert sandstone, siltstone, shale	250 ft	Eastern part of Mount Drummond Sheet area	*Xystridura* *Fuchouia*, *Paterina*	Relationship with Camooweal Dolomite not clear
		and undifferentiated Middle Cambrian (Єm)	Crystalline dolomite and chert	unknown	Ranken and Alroy Sheet areas	Trilobite and brachiopod fragments	On Ranken may be equivalent to Ranken Limestone; on Alroy may be equivalent to Wonarah Beds
		Anthony Lagoon Beds (Єmy)	Limestone, dolomite, dolomitic limestone, quartz sandstone and siltstone	1050 ft	Brunette Downs and Wallhallow Sheet areas	Algae, trilobite and echinoderm fragments; brachiopods in Brunette Downs No.1 Well	Unconformably overlies Mittiebah Sandstone. May be equivalent to other Middle Cambrian units
		Ranken Limestone (Єmk)	Crystalline limestone, silicified limestone and coquinite. Some chert nodules	unknown	Valley of the Ranken River on Ranken and Avon Downs Sheet areas	*Kootenia*, *Asaphiscus* *Peronopsis*, *Archaeocyathus*, *Biconulites*, *Hyolithes*, *Helcionella*, *Cymbionites*, *Peridionites*, *Eocystis*, *Acrothele*, *Lingulella*, *Bohemiella*, *Nisusia*(?), *Asthenopsis*, *Papyriaspis*	Contains some upper Middle Cambrian fossils at one locality, but is mainly lower Middle Cambrian. May inter-tongue with Wonarah Beds to the west.

Sheet 2 - TABLE 1.

AGE		ROCK UNIT & SYMBOL		LITHOLOGY	THICKNESS	DISTRIBUTION	FOSSILS	STRATIGRAPHIC RELATIONSHIP
CAMBRIAN	MIDDLE CAMBRIAN	Wonarah Beds (Єmw)		Silicified limestone, siltstone, sandstone, chert, silicified dolomite and shale. Leached carbonate rocks	At least 350ft; may exceed 1000 feet	South-western part of Ranken Sheet area, north-western part of Avon Downs Sheet area, and south-eastern part of Alroy Sheet area	*Xystridura browni*, *Xystridura* spp, *Pagetia significans*, *Oryctocephalus*, *Peronopsis* spp *Helcionella*, Ptychoparids, Brachiopods	May be continuous with Gum Ridge Formation (Ivanac, 1954) and other Middle Cambrian rocks in the Barkly Tableland
		Burton Beds (Єmb)		Siltstone and chert, calcarenite, coquinite, crystalline limestone	300 ft +	Northern part of Ranken Sheet area, southern part of Mount Drummond Sheet area	*Xystridura*, *Pagetia*, *Peronopsis*, *Lyriaspis alroyensis*, *Biconulites*, Brachiopods	Unconformably overlies Mittiebah Sandstone
		Peaker Piker Volcanics (Єmp)		Basalt and trachyte, minor sandstone	120 ft	Western part of Mount Drummond Sheet area		Unconformably overlies Mittiebah Sandstone. May be equivalent to volcanics regarded elsewhere as Lower Cambrian
	MIDDLE OR LOWER CAMBRIAN	Top Springs Limestone (Єt)		Massive fine-grained and crystalline limestone	30 ft +	Northern part of Wallhallow Sheet area	*Redlichia* cf. *forresti*	Possibly underlies Anthony Lagoon Beds. Unconformably overlies Bukalara Sandstone
	LOWER CAMBRIAN	Bukalara Sandstone (Єlb)		Quartz sandstone and conglomerate	200 ft	Northern parts of Mount Drummond and Wallhallow Sheet areas		Unconformably overlies Adelaidean rocks
		Camooweal Dolomite (Єd)		Crystalline dolomite with chert nodules and bands dolomitic limestone. Minor sandstone	300 ft +	Ranken, Avon Downs and Mount Drummond Sheet areas	No fossils in surface exposures. Cambrian shelly fossils in Lake Nash No.1 and BMR 11 (Cattle Creek(	Interfingers with Middle Cambrian rocks in the Camooweal area (Randal and Brown, 1962c); overlies Middle Cambrian rocks in the Avon Downs (Randal, 1966c) and Mount Drummond Sheet areas (Smith and Roberts, 1963); and underlies Middle Cambrian rocks in the Lawn Hill Sheet area (Carter and Opik, 1961)
PRECAMBRIAN	ADELAIDEAN	South Nicholson Group	Mittiebah Sandstone (Bui)	Quartz sandstone	9000 ft	Western part of Mount Drummond Sheet area; northern part of Ranken Sheet area; and eastern boundary between Brunette Downs and Wallhallow Sheet areas		The South Nicholson Group unconformably overlies the McArthur and Tawallah Groups, the Benmara and Bluff Range Beds, the Carrara Range Formation and the Murphy Metamorphics. It is probably equivalent to the Roper Group
			Undifferentiated (Bs)	Sandstone, siltstone	20,000 ft	Widespread on Mount Drummond Sheet area		
		Roper Group (Br)		Quartz sandstone and siltstone	4000 ft	Northern part of Wallhallow Sheet area		Unconformably overlies McArthur Group

Sheet 3 - Table 1.

AGE		ROCK UNIT & SYMBOL	LITHOLOGY	THICKNESS	DISTRIBUTION	FOSSILS	STRATIGRAPHIC RELATIONSHIP
PRECAMBRIAN	CARPENTARIAN	McArthur Group (Bm)	Sandstone, siltstone, dolomitic sediments	4000 ft	Northern parts of Wallhallow and Mount Drummond Sheet areas	Stromatolites	Conformably overlies Tawallah Group in northern Wallhallow area but unconformably overlies Tawallah Group in Calvert Hills area (Roberts et al. 1964)
		Tawallah Group (Bt)	Sandstone, siltstone, dolomitic sediments	4000 ft +	Northern part of Wallhallow Sheet area	Stromatolites	Unconformably overlies Murphy Metamorphics in Calvert Hills area (Roberts et al. 1964)
	LOWER(?) PROTEROZOIC	Benmara Beds Bluff Range Beds Carrara Range Formation Murphy Metamorphics (Bl)	Sandstone, siltstone, volcanics, limestone, dolomite, conglomerate, schist, greywacke	1700 ft 9000 7650 ?	Eastern Mount Drummond Sheet area		Unconformably underlies South Nicholson Group

Arnhem Land. With the exception of some units on the Mount Drummond Sheet area they occur mainly in the Gulf Fall Division beyond the northern margin of the Barkly Tableland. Only the Mittiebah Sandstone, which is the youngest exposed unit of the Precambrian sequence, may have some bearing on the groundwater of the Barkly Tableland, and is the only Precambrian unit which will be described in this report. The other units are described by Plumb & Rhodes (1964) and Smith & Roberts (1963). Precambrian rocks are associated with springs and waterholes in the north-eastern part of the region and are briefly described in the section on surface water.

Most of the region is underlain by Proterozoic, Cambrian, Mesozoic, and Tertiary rocks. The Proterozoic rocks crop out only around the margin of the region, and their distribution and nature in the subsurface of the region are unknown. The Cambrian succession may be underlain in the west by the Lower Proterozoic Warramunga Group and the Precambrian Ashburton Sandstone+ (Noakes & Traves, 1954; Ivanac, 1954), in the north and north-east by the Adelaidean Mittiebah Sandstone, and in the south and south-west by the Lower Proterozoic Hatches Creek Group (Smith et al., 1961).

In the areas underlain by Cambrian rocks, stratigraphic information is obtained with difficulty owing to the paucity of outcrop and the lack of exposed contacts. Large areas are covered by black soil or sand with floaters of dolomite, limestone, and sandstone, and by an extensive cover of chert pebbles and pisolitic ironstone gravel. Sandstone and siltstone outcrops are heavily lateritized, and in places it is impossible to differentiate between Cambrian and Mesozoic rocks. There are approximately 450 water-bores in the region, but only a fraction of the logs contain drillers' descriptions of rock types; in the majority of these the information has little stratigraphic value.

It is difficult to define rock units because of the lack of stratigraphic information and consequently most of the Cambrian units are described by the general term "Beds". Formations may be recognized if more detailed subsurface information becomes available.

\+ Now named Tomkinson Creek Beds (Randal, Brown, & Doutch, in prep.)

Adelaidean

The Mittiebah Sandstone is the youngest exposed unit of the Carpentaria Proterozoic Province (Dunn, Smith & Roberts, in prep.). The Sandstone crops out as high ridges in the western part of the Mount Drummond Sheet area. Isolated outcrops occur in high country around the headwaters of Creswell Creek, and between the Playford River and Buchanan Creek, south of Alexandria Homestead.

The unit consists of mainly fine to medium-grained, quartz sandstone; glauconitic sandstone occurs near the base and rare pebbles and cobbles occur sporadically throughout the unit. The rock is friable but in places is extensively silicified. Bedding ranges from medium to very thick; cross-beds are numerous, ripple-marks are rare, and the rocks are jointed.

Folding in the Mittiebah Sandstone is moderate; around the headwaters of Creswell Creek the rocks dip less than 5^0 to the south-south-west; south of Alexandria Homestead the rocks are gently folded in a small anticline whose axis strikes east-north-east; north of Alexandria the rocks are gently folded. Smith & Roberts (1963) estimate the thickness of the Mittiebah Sandstone as 9000 feet; the unit conformably overlies the Adelaidean Mullera Formation and is unconformably overlain by Middle Cambrian rocks.

Cambrian

The Cambrian rocks in the region are part of a widespread Cambrian succession which occurs in the Barkly Tableland, and adjoining areas in both the Northern Territory and Queensland. Since 1948 the regional geology and palaeontology of this sequence has been studied by Öpik (1956a, b). The distribution, rock types, and stratigraphic relationships of the Cambrian units are given in Table 1. The position of the units in the table does not necessarily imply superposition as some may be partly equivalent.

The Bukalara Sandstone, of Lower Cambrian age, crops out in the region only in the northern parts of the Wallhallow and Mount Drummond Sheet areas; it does not occur in the Georgina Basin and has no bearing on the groundwater of the Barkly Tableland. The Peaker Piker Volcanics crop out in the western part of the Mount Drummond Sheet area. Smith & Roberts (1963) regard them as Middle Cambrian and consider they underlie the Burton Beds. The volcanics have probably a restricted distribution as bore No. 1 Alexandria (R.N. 735) penetrated the Cambrian sequence and intersected the Mittiebah Sandstone without encountering the volcanics. They are not evident beneath the Cambrian sequence in the eastern part of the Brunette Downs Sheet area: Papuan-Apinaipi Brunette Downs No. 1 spudded in Cambrian limestone and passed into the Mittiebah Sandstone at 1060 feet (Randal, 1966).

Outcrops of fossiliferous Middle Cambrian rocks - Currant Bush Limestone and Border Waterhole Formation - occur in small areas north of Don Creek in the eastern part of the Mount Drummond Sheet area. These rocks are not definitely known in the sub-surface in this area; the closest bores are in outcrop areas of the Camooweal Dolomite and are producing water presumably from the Dolomite.

The distribution and nature of the Cambrian rocks of the Tableland proper have, as will be shown later, a marked influence on the distribution of the groundwater. A discussion on the lithologic variations throughout the region and the probable structure of the region is pertinent at this point.

The Cambrian rocks are essentially a carbonate sequence, but different environments and the variations in the amount of interbedded non-carbonate material in the sequence have produced distinctive units.

The Ranken and part of the Avon Downs Sheet areas are mainly underlain by Camooweal Dolomite consisting of dolomite with chert bands and nodules. The colour is variable - white, cream, buff, light brown. The white dolomite is generally more coarsely crystalline and porous than the darker dolomite and sometimes is sugary and friable. The Camooweal Dolomite is medium and thick-bedded; it is cavernous. Its age and relationship with other Cambrian rocks are not clear and are discussed in the references previously cited (see also Table 1). Sandstone boulders which are found on the surface with dolomite boulders, may represent sandstone beds within the dolomite. No fossils have been found in outcrops of the Camooweal Dolomite, but two stratigraphic holes spudded into the Camooweal Dolomite yeilded Cambrian fossils at depth (Randal, 1966c). The Dolomite is generally covered by downs country of black soil with Mitchell grass. It may have been deposited as a carbonate mud in a warm shallow sea under quiet conditions - presumably an environment of evaporation and precipitation (Nichols, 1963; Randal & Brown, 1962c). Rocks previously mapped as Camooweal Dolomite near Lake Nash Homestead are now regarded as the Upper Cambrian Meeta Beds which crop out in the Sandover River Sheet area (Nichols, 1966).

The exposed Cambrian rocks in the west (Ranken Limestone) and north-west (Burton Beds) of the Ranken Sheet area have marked lithologic differences. The Ranken Limestone, which crops out in the valley of the Ranken River, consists of fine-grained limestones with pellets and fossil fragments in a fine-grained matrix; sandstones and siltstones are rare, but silicified coquinites and fossiliferous chert pebbles are common. Its relationship with the Camooweal Dolomite in the eastern part of the Ranken Sheet area is obscure. East of the Ranken River it grades into a white, fossiliferous dolomite. Core hole Grg 16 (Milligan, 1963) was drilled to determine the relationship of the Ranken Limestone to the Camooweal Dolomite near the Ranken River; Milligan reports (op.cit.) dolomite overlying fossiliferous limestone, but as the fossils have yet to be determined the relationship between this limestone and the outcropping Ranken Limestone is still unknown. Milligan also records that this limestone is similar to the Burton Beds described by Randal & Brown (1962a). Fossil evidence suggests the Ranken Limestone is a lens in the Wonarah Beds (Öpik, 1956 b). It has been interpreted as a shore-line deposit (Öpik, op.cit); the thickness is unknown.

The Burton Beds crop out in the north-western part of the Ranken Sheet area and the south-western part of the Mount Drummond Sheet area. They consist of lateritized shale and mudstone, siliceous in part, chert, limestone and siltstone; carbonate rocks are frequently fragmented and often are coquinites; oolitic rocks and chert pebbles are common. The relationship of the Burton Beds to the Camooweal Dolomite is not definitely known because of the lack of exposed contacts; on the Mount Drummond Sheet area outcrops of Camooweal Dolomite appear to overlie the Burton Beds (H.G. Roberts, BMR, pers. comm.). D.R.G. Woolley (BMR, pers, comm.) reports that a new quarantine bore north of Connell's Bore on the Barkly Stock Route intersected 200 feet of dolomite overlying limestone. It is not known whether or not this dolomite is continuous with the Camooweal Dolomite to the south-east, as the occurrences are separated by many miles of soil cover and outcrops of the Burton Beds. A similar dolomite occurs in the eastern part of Brunette Downs both on the surface and in water-bore chips; these dolomites north of the Playford River may be continuous with the Anthony Lagoon Beds.

Wells and water-bores which have penetrated to basement indicate the Burton Beds probably fill depressions in the basement surface. Nichols (1963) considers that the environment of deposition was shallow water in an open shelf area. The thickness is unknown but may exceed 300 feet. (Randal & Brown, 1962a). Fossil assemblages in the Burton Beds indicate a lower Middle Cambrian age; Öpik (1956b) suggests these rocks+ may be continuous with the Wonarah Beds, and Randal & Nichols (1963) have supported this opinion.

The Wonarah Beds occur in the north-western part of the Avon Downs Sheet area, the south-western part of the Ranken Sheet area, and the eastern part of the Alroy Sheet area. They occur west of the Ranken River and south of Alroy Downs Homestead but the contact with the other Cambrian units has not been observed.

The rocks consist of fossiliferous siltstone, chert, sandstone, silicified shale, and silicified oolitic limestone, leached carbonates, and blue-grey silty limestone. Milligan (1963) describes limestone, calcareous siltstone and sandstone, calcarenite, coquinite, and dolomite from the core-holes, but the fossils have yet to be identified and all rock types do not occur in each bore. Fossils from the surface outcrops of the Wonarah Beds indicate a lower Middle Cambrian age; the total thickness to magnetic basement at Wonarah is 800 feet (Jewell, 1960) but it is not known if this contains rocks older than lower Middle Cambrian. Similarly it is not known if the 1024 feet of limestone and dolomite in Frewena No. 1 (E.A. Webb, pers. comm), is all referable to the Wonarah Beds.

The water-bore at Wonarah Telegraph station penetrated 366 feet of dolomite and limestone containing lower Middle Cambrian fossils (Randal, 1966d).

There is good evidence for the continuity of the Wonarah Beds with the Burton Beds (Randal & Nichols, 1963); continuity with the Sandover Beds and the Gum Ridge Formation is probable but has not been proved. The relationship of the Wonarah Beds to the Anthony Lagoon Beds to the north is not proved but they may be in part contemporaneous.

The Anthony Lagoon Beds crop out in the central and northern parts of the Brunette Downs Sheet area and extend northwards on to the Wallhallow Sheet area. Outcrops consist of dolomite, dolomitic limestone, algal dolomite, sandstone and leached carbonates but drillers' logs suggest siltstone and sandstone are more prominent than the outcrops indicate. The carbonate rocks

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+ Öpik (1957) referred to these rocks as the "Alexandria beds".

of the Anthony Lagoon Beds show the marked leaching effects seen in carbonate rocks elsewhere on the Barkly Tableland; the sandstones are extensively lateritized and ferruginized. The maximum known thicknesses of the Anthony Lagoon Beds are from Brunette Downs water-bore K5, where the drillers log describes 707 feet of limestone, and from Papuan-Apinaipi Brunette Downs No. 1, where 1060 feet of carbonate overlie Precambrian rocks (Randal, 1966a).

No diagnostic fossils have been found in the Anthony Lagoon Beds; algal and sponge (?) remains have been found in dolomitic limestone, and fragments of trilobites and echinoderms have been seen in thin sections; fragments of brachiopods were found in Core 2 (1010-1019 feet) from Brunette Downs No. 1. Fragmental limestones are similar to the Ranken Limestone, but the equivalence is only conjecture. The Anthony Lagoon Beds may overlie the Top Springs Limestone (Plumb & Rhodes, 1964) to the north, and may be an equivalent in part of the Burton Beds and the Wonarah Beds.

The Anthony Lagoon Beds were deposited in shallow water with medium current activity. Shallow lagoonal conditions favoured the growth of algae and sponge-like organisms while more open shelf conditions favoured the accumulation of intraclastic and pelletal limestones.

Mesozoic

Mesozoic rocks crop out as remnants on low rises in small areas east of the Ranken River; they occur as a scattered rubble of quartz sandstone and pebble conglomerate. On the Wallhallow Sheet area, Mesozoic rocks crop out on the scarp at the northern edge of the Barkly Tableland and extend southwards under the black soil to near Collabirrian Waterhole. The rocks consist of white quartz sandstone overlain by a massive grey calcareous siltstone containing gypsum and claystone. The rocks heavily lateritized. Plumb & Rhodes (1964) estimate a thickness of 200 feet, but it is unlikely that this thickness persists southwards. There is no evidence that Mesozoic aquifers occur in this portion of the Barkly Tableland. The sediments/may influence recharge and the chemical composition of the water in the northern part of the region.

Cainozoic

Tertiary limestone occurs in two areas in the region - in the Barkly Internal Drainage Basin and in the Georgina River Basin. The two units respectively named the Brunette Limestone and the Austral Downs Limestone (Noakes & Traves, 1954) consist of white to brown, fine-grained and coarsely crystalline limestone and dolomite. They contain chert and opaline nodules and smears; the limestone is often irregularly nodular. These rocks are thin deposits unconformably laid down on the older rocks from which they were derived. The Tertiary limestones appear to have no direct influence on the groundwater, however, percolating waters recharging the Cambrian reservoirs may pass through them or their weathering products.

Outcrops of travertine are widespread in the south-western part of the region. The travertine is in part opaline and siliceous like the Tertiary limestones; however it contains more detrital quartz and is not so cohesive. It is at least 15 feet thick.

Unconsolidated Cainozoic deposits are widespread in the region; they consist of black and grey clayey soils, alluvium, sand and sandy soils, river gravels, and residual gravelly rises of chert and ironstone pebbles.

The grassy downs country is underlain by black and grey pedocalcic soils, moderately to weakly leached and with carbonate and gypsum horizons. Stewart (1954b) considers the areas now occupied by these soils were swamplands during the Tertiary lateritic cycle with the water table at or above their surface. These soils overlie the carbonate rocks of the Cambrian sequence and the Tertiary limestones; they are of mixed origin, partly residual on the carbonate rocks and partly from material deposited in the Tertiary swamp. Chert gravel is widespread and may be residual from chert nodules and bands in the underlying carbonate rocks. Rises of pisolitic ironstone gravel are presumably remnants of lateritic horizons, but in places are detrital laterites derived from re-working of the lateritized material.

Sand and sandy soils occur in the southern parts of the Alroy Sheet area and the western part of the Brunette Downs Sheet area. Quartz sand is often subordinate but gives the soil a sandy texture which is distinct from the clayey nature of the black pedocalcic soils. This is particularly so in the timbered area west of Lake Sylvester where grey pedocalcic soils have a texture and vegetation more in common with the sandy areas than with the grassy downs country. The soils shown on the map as sand and sandy soils are termed by Stewart (1954b) red desert alluvial soils, calcareous desert soils, lateritic red sand and lateritic red earths.

SURFACE WATER

The barkly Tableland has an annual rainfall of about 11 inches in the south, ranging to about 21 inches in the north. The rainfall is derived mainly from the north-west monsoon commencing in November-December and ending in March. Figure 3 shows the annual isohyets for the region based on the average rainfall for the period 1950 to 1962+. There is a slight variation between the figures for 1950-62 and those given by Slatyer & Christian (1954) for the period 1911-1940:

	1950-62	1911-40
Newcastle Waters	1786 points/year	1732 points/year
Camooweal	1626 " "	1435 " "
Alexandria	1248 " "	1407 " "
Tennant Creek	1308 " "	1385 " "
Avon Downs	1377 " "	1274 " "

The driest parts of the region are in the area bounded by Alroy, Frewena, Ranken, and Wonarah, and the area west of the Ranken and southern part of the Georgina Rivers. These areas are adjacent to a large semi-desert which extends southwards to the Sandover River.

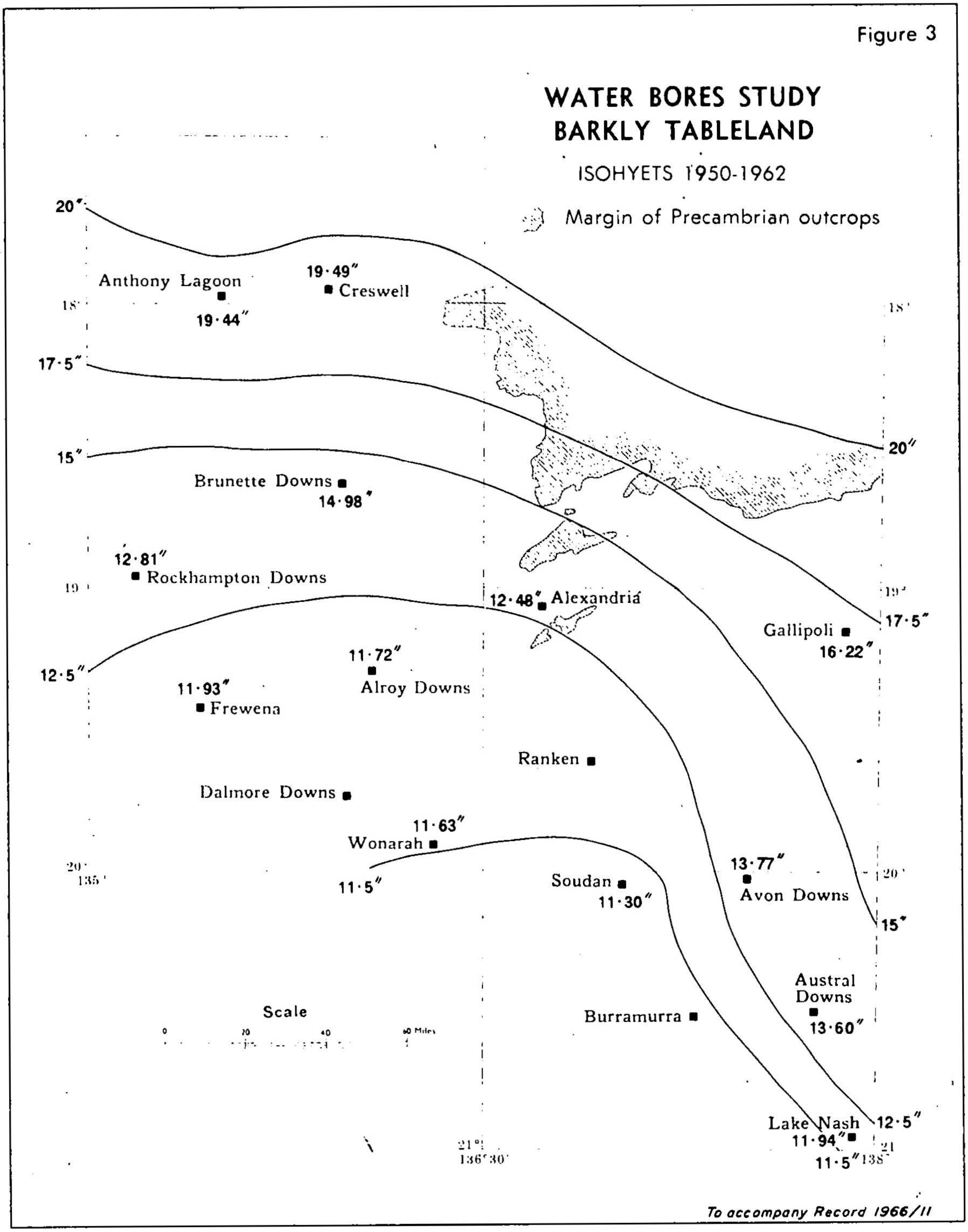
Figure 4 shows the seasonal variation of rainfall at Alexandria and clearly indicates the separation of wet and dry seasons, and the incidence of occasional winter rains.

The annual evaporation in the region ranges from 100 inches in the north to over 110 inches in the south. Evaporation is at its highest during the wet season and lowest during the dry. However the evaporation/precipitation ratio is lowest in the wet - about 2.75 in January - and highest in the dry season - greater than 200 in August. This factor is important as it implies the improbability of accretion to the groundwater supplies from occasional low-intensity rainfall during the normal dry season. Figure 4 also shows the variation throughout the year of evaporation at Alexandria Homestead.++

+ Obtained from monthly rainfall figures for eleven stations in the region and adjacent to it for the period 1950-1962, made available by the Director, Commonwealth Bureau of Meteorology, Melbourne.

++ Information provided by Commonwealth Bureau of Meteorology, Melbourne.

Figure 3



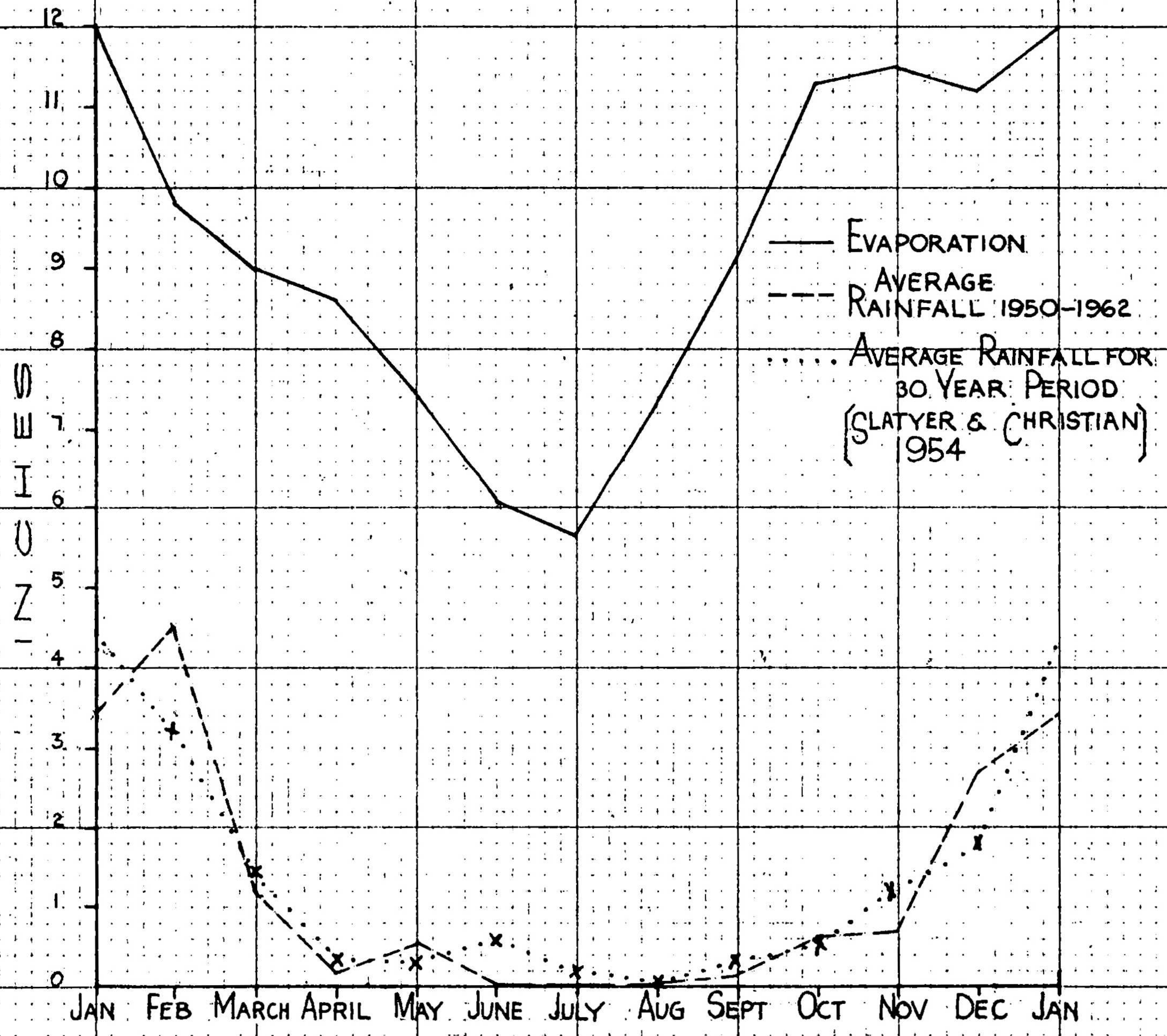
WATER BORES STUDY
BARKLY TABLELAND

ISOHYETS 1950-1962

To accompany Record 1966/11

Figure 4

MEAN RAINFALL AND EVAPORATION AT ALEXANDRIA STATION ... N.T.



To accompany Record 1966/11

Bureau of Mineral Resources, Geology and Geophysics

NT/A/108

Because of the low seasonal rainfall and the high evaporation, surface water on the Barkly Tableland is not only inadequate for the present stock population, but is also unreliable. Foley (1957) states that in 70 years of rainfall records the region has experienced periods of drought totalling 25 years 8 months up to 1955. This period was followed by dry years in 1958 and 1961. Alexandria's total of 353 points for 1958 is the lowest on record, and in 1961 Alexandria received only 503 points. Serious droughts occurred in the period 1911 to 1916 with 1911/12 and 1916 the worst years. One of the worst droughts was from March 1951 to October 1952; hundreds of cattle died in January and February 1952 - months during which normally over 50 percent of the annual precipitation occurs- and by April 1952 very little grass was available and most of the permanent waterholes were dry.

There are few permanent waterholes on the Barkly Tableland owing to the low relief, the few streams, and the arid climatic conditions. There are no permanent streams; even the Nicholson River in the north-east shrinks to a series of waterholes during the dry. Most permanent waterholes occur in the Gulf Fall Division where the streams are entrenched in small canyons; however the demand for water is greatest in the rich downs country to the south in the Georgina River Basin and the Barkly Internal Drainage Basin.

Gulf Fall Division

In the north-eastern part of the Gulf Fall the major watercourse is the Nicholson River which flows eastwards across the north of the Mount Drummond Sheet area and eventually enters the Gulf of Carpentaria near Burketown, Queensland. The South Nicholson River, Carrara Creek, and Buddycurrawa Creek are the principal tributaries of the Nicholson River. The South Nicholson and Nicholson Rivers carry large volumes of water during the wet season but soon become a series of isolated waterholes at the onset of the dry season; many of these contain water until the ensuing wet season, when they are replenished. Most of the waterholes along the Nicholson and South Nicholson Rivers are simple depressions in the river beds, or in the numerous anabranches, but a substantial number are associated with rock bars - the water either being dammed by resistant sandstone beds, or forming a pool on the downstream side of the bars. These features are due to the streams having been superimposed on the dipping Proterozoic rocks after having developed on horizontal Cretaceous strata.

Permanent springs are numerous in the eastern and central parts of the Mount Drummond Sheet area. They occur at the contact between sandstone hills and less resistant and relatively impervious siltstone and shale. Folding and faulting of the Proterozoic rocks has broken the continuity of individual aquifers within them. This has prevented the movement of groundwater in a regional aquifer system, and has produced groundwater systems of small areal extent with piezometric surfaces close to the ground surface, and with recharge areas close by. Because of the topographic relief the piezometric surfaces in places lie above the ground surface, and if the permeability of the rocks permit, groundwater is discharged in a spring. This is in direct contrast to the groundwater system of the Barkly Tableland further south where the piezometric surface of the groundwater in the undisturbed Cambrian rocks remains well below ground level.

The north-western part of the Gulf Fall Division is drained by the headwaters of the McArthur River, and its tributaries, the Kilgour River and Clyde Creek. These streams flow northwards to the Gulf of Carpentaria. They are non-perennial and each becomes a series of isolated water holes during the dry season; these water holes are especially prevalent within deep gorges and valleys where the Kilgour and Clyde, and their tributaries, flow over Proterozoic rocks. The waterholes occur both as depressions in the stream bed and also where they are dammed by rock bars.

Springs, usually small, occur in the north and north-eastern parts of the Wallhallow Sheet area. They yield clear water, presumably suitable for human consumption, but little is known about them. Many occur around the edges of the Bukalara Sandstone Plateau and are probably controlled by the contact between the Bukalara Sandstone and underlying rocks. Others occur within folded and dissected Proterozoic rocks, but the geological control is obscure.

Georgina River Basin

The annual rainfall in the Georgina River Basin ranges from 11 inches in the south and west to over 16 inches in the north, but over most of the area it is less than 15 inches. The streams, which are mature and in places braided, have well defined, but low, valley profiles. Consequently there is little scope for water conservation by means of dams. Low overshot dams have been constructed at Avon Downs and Austral Downs, but these structures are unreliable in comparison to bores: the drainage is frequently incised with a consequent lack of storage area, or the swift flow during the wet season breaches the dam.

The Georgina, Ranken (including Lorne Creek), and James Rivers are the only streams which normally contain permanent water-holes; those at Soudan, Avon Downs, Austral Downs, and Lake Nash are normally adequate for homestead use, even in moderate drought conditions. Surface water is often milky because of a high content of clay material in suspension; strong evaporation concentrates the mineral matter and frequently, towards the end of the dry season, the surface waters become less palatable than some bore-waters.

In relation to its area the Georgina River Basin is considerably better endowed with surface water than is the Barkly Internal Drainage Basin; there are over fifty recognized waterholes, about 20 percent of which are normally regarded as permanent. There are no recorded springs in the area.

Barkly Internal Drainage Basin

This area is poorly endowed with surface water resources: it contains about 60 recognized waterholes, less than a quarter of which are permanent. The normally permanent waterholes are unreliable in moderate drought conditions. Waterholes have been deepened on some stations and overshot dams constructed. However only two dams are in existence at present: Buchanan Dam, east of Alroy Downs Homestead, and a system of small dams impounding water in the lagoon at Brunette Downs Homestead. Buchanan Dam is the largest dam on the Tableland: the water is backed up for over 1½ miles and in places is 200 yards wide, the depth is unknown but in places exceeds 10 feet.

Most of the major streams contain permanent waterholes: the most reliable of these are the waterholes at Alroy Downs Homestead, Anthony Lagoon, Brunette Downs Homestead, and Corella Lagoon. There are no permanent waterholes in the Internal Drainage Basin north of Creswell Downs and Anthony Lagoon Homesteads.

As with the Georgina River Basin the surface waters have a high content of suspended clay material, and some waterholes are encrusted with gypsum. The following are analyses by the Animal Industry Branch N.T.A., Alice Springs of water samples taken in November and October, 1960 respectively:

		Na	K	Mg	Ca	Cl	SO_4	HCO_3	F	NO_3	TDS
Brunette Downs Lagoon	ppm	6	7	6	12	1	2	92	0.2	0.	126
	epm+	0.26	0.18	0.5	0.6	0.03	0.4	1.5			
Long Water-hole	ppm	66	15	55	287	15	909	155	1.0	2	1505
	epm	2.87	0.38	4.52	14.35	0.42	18.94	2.54			

The water from Long Waterhole on Brunette Creek is a sulphate type with calcium the major cation. Although dolomitic rocks occur in the area, there is a great deal of gypsum in the black soil nearby. The dissolved salts in the lagoon at Brunette Downs appear to be derived mainly from the solution of dolomitic rocks or their weathering products.

There are no permanent waterholes in the southern desert country of the Internal Drainage Basin. Water lies in bluebush swamps and claypans for only a short period after heavy rain. As the vegetation is not suitable for cattle grazing, the only bores are along the Barkly Highway, except for core-hole Grg 17, 1½ miles south of Frewena, which was completed as a water-bore.

The large lakes of the Internal Drainage Basin contain water only during the wet season and, depending on the amount of rainfall, for some weeks after it. The lakes are shallow and quickly dry out. Large normally permanent waterholes occur in the distributaries of the streams feeding these lakes e.g. Adder Waterhole in Creswell Creek, Corella Lagoon in Corella Creek, and occasionally Dookamunda Waterhole on the Playford River.

+ Equivalents per million (or milli-equivalents per litre), obtained by dividing the concentration of a particular ion in parts per million by its equivalent weight.

GROUNDWATER

DEVELOPMENT

Collection and reliability of date

A detailed study of the hydrodynamics of the groundwater in this region and its detailed relationship to geology is impossible because of the lack of accurate hydraulic measurements, incomplete bore records, lack of accurate elevations, and an incomplete knowledge of the geology and structure. Only a broad regional evaluation of groundwater environment and movement can be made with the presently available data, but this evaluation not only points the way for further study, but shows that an understanding of the groundwater will assist geological interpretation. The chemical analyses of the groundwater has considerably helped in the study of both hydraulics and geology but much remains to be done.

Information on bores has been obtained mainly from drillers' logs and consequently is of varying reliability. The depths of aquifers and of standing water levels are not always measured accurately: in cases where anomalous figures occur they must be treated with caution unless reasonable explanations for the anomaly are apparent. Additional information has been obtained from station owners and managers and from the Water Resources Branch of the Northern Territory Administration: as these sources rely on the original drillers' logs their accuracy cannot always be taken for granted because of transcription errors. Noakes and Traves (Traves & Stewart, 1954) collected additional information in 1953. Logs of bores drilled since then were collected in the field during 1961 and 1962, and by correspondence with drillers and pastoralists in 1963.

Many of the bore logs are incomplete, and for some bores no information whatever is available. However this situation has improved in recent years and drillers are now required by regulation to submit a satisfactory log to the Water Resources Branch. The technical information required by the Branch is as follows: location, total depth of bore, depth and number of aquifers, standing water levels, pump depth and draw -down during pumping, and a record and samples of strata penetrated.

Four hundred and forty-seven bores have been located in the region; the available information is summarized in Appendices A and B. Probably more than this number have been drilled but some records and locations have been lost. For example an apparently unsuccessful bore was drilled on Alexandria aerodrome, but no information is available.

A little over half the bore-logs examined record the depths of the aquifers; 315 record the depth of the standing water level, but only a few the standing water level for the individual aquifers; 200 record the pump depth and 309 the supply. Only 86 of the logs record all measurements. Very few logs record the supply for the shallower aquifers; also the supply quoted for the main aquifer can be misleading since in some areas it is clearly the limit of the pumping equipment then in use, or else is an estimate only - and in recent years an estimate by air-lifting. Very few logs record the draw - down and the recovery times for the bores during pumping tests. The various parameters have not always been measured accurately, and in some areas an error of ± 5 feet can be significant. Standing water levels are measured at the time of completion of a bore and only occasionally are remeasured at a later date. Consequently, since some of the levels have been recorded over 60 years ago, it may not be correct to equate them to levels measured only recently. Most pastoralists regard the standing water level as virtually constant but this is purely a subjective belief, and for a detailed study it should be re-measured.

Surface elevations have been obtained by barometric levelling, both by the Division of National Mapping and, later, by the Bureau of Mineral Resources during the geological mapping of the region. Barometric stations were re-occupied at least once during the survey, and some have been checked against and tied to a line of third order levels set up by the Department of the Interior along the road from the Barkly Highway to Anthony Lagoon Homestead. The barometric levels are considered to be sufficiently correct to permit reduction of the elevation of the standing water levels on a regional scale.

The lack of surveyed topographic levels, and the possibility of inaccurate measurements of the standing water levels, prevent an accurate determination of the relative heights of the standing water levels in adjacent bores, and hence prevents the detailed interpretation of groundwater movement as depicted by the piezometric surface. The problem is particularly relevant in the central part of the Barkly Internal Drainage Basin where the topographic variation is slight and the hydraulic gradients apparently small.

But over the entire region the topographic variation is large enough and the measured standing water levels diverse enough to produce a piezometric surface with a variation of about 250 feet. In some areas the variation of the piezometric surface is about 40 feet or more which is greater than the expected error caused by faulty measurements and levelling. The piezometric surface illustrated in Figure 9 and Plate 5 is considered to be regionally valid.

Samples for analyses were obtained in 1962 and were analysed by the Bureau of Mineral Resources, Canberra, and by the Australian Mineral Development Laboratories, Adelaide. In addition, other analyses were made available by the Animal Industry Branch of the Northern Territory Administration. The collection techniques and the reliability of the chemical results are discussed in the section on chemistry.

History of Drilling

Stock was first moved by pastoralists into the Barkly Tableland during the 1870's and it quickly became apparent that a pastoral industry would be severely hampered by the inadequacy of the surface water. After the initial success of water-bore drilling in the Great Artesian Basin, pastoralists on the Tableland noted the similarity of this region to the Artesian Basin, and brought in drilling contractors to seek groundwater (Fig. 5).

Rocklands Station was the first to commence drilling, and in 1890 drilled two successful bores in the Queensland part of the holding, but within a few miles of the Northern Territory border. These were followed by two successful bores in 1891, again in the Queensland part of the holding.+ The first bores in the Northern Territory part of the Tableland were Rocklands No. 5 (R.N. 939) and No. 6 (R.N. 940) on Western and Cattle Creeks respectively; both were drilled in 1892. All these bores intersected sub-artesian aquifers from depths less than 500 feet.

Alexandria No. 1 Bore (R.N. 735) was drilled about 1893; it is the deepest water-bore on the Barkly Tableland (1760 feet), and apparently was the first and only serious attempt to search for artesian water in the region. It obtained a good supply of sub-artesian water at 238 feet, but the driller's

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+ These bores, though outside the area of this report, are included in this section because of their historical interest.

log records no other aquifer between this level and the total depth.

No drilling was undertaken on Rocklands between 1893 and 1897. In 1898 Rocklands Nos 9, 10, and 11 were drilled, the last two in the Northern Territory. By 1900 Rocklands Station had drilled several successful bores on both sides of the border and in that year the adjoining property of Avon Downs successfully drilled their No. 1 bore (R.N. 366).

In the ensuing five years 23 bores were drilled compared to 13 bores in the previous 10 years. This increased activity was presumably caused by a long drought which lasted from late 1899 until early 1906, and by the apparent ease with which groundwater could be obtained. The drilling was mainly on Rocklands and Alexandria, but in addition Brunette Downs Nos. 1 to 6 were drilled in the period 1903 to 1904, and drilling commenced on Lake Nash in 1903. In 1904 the first recorded dry holes were encountered after the successful drilling of over 30 bores in 14 years. Alexandria No. 6 (R.N. 741) on the Ranken River was drilled to 608 feet without striking any aquifers; Alexandria No. 8 was drilled in the same year to 408 feet without obtaining water. By 1905 eight bores had been drilled on Herbert Vale. The old Herbert Vale bores on the Northern Territory side of the border are now known as Gallipoli Homestead Bore, and Gallipoli Nos. 5, 6 and 7; those on the Queensland side have been incorporated into Rocklands Station, but have retained their original numbers.

Drilling declined until 1909 and then was resumed on Alexandria, Avon Downs, and Rocklands; in the period 1909 to 1913 ten bores were drilled on these stations. In spite of the First World War, or perhaps because of it, the period 1914 to 1920 brought added drilling to the Barkly Tableland, on Austral Downs, Brunette Downs, Alexandria Downs and Rocklands. The first bores on the present Creswell Downs were drilled on the old Wallhallow block in 1916 and 1917 (R.N. 952, 960, 961), and the first bores on Anthony Lagoon in 1919. The first recorded government drilling in the Barkly Tableland were Bore Nos. 1 and 2 (R.N. 525, 524) on the Anthony Lagoon Stock Route in 1919 (now regarded as the western extension of the Barkly Stock Route.)

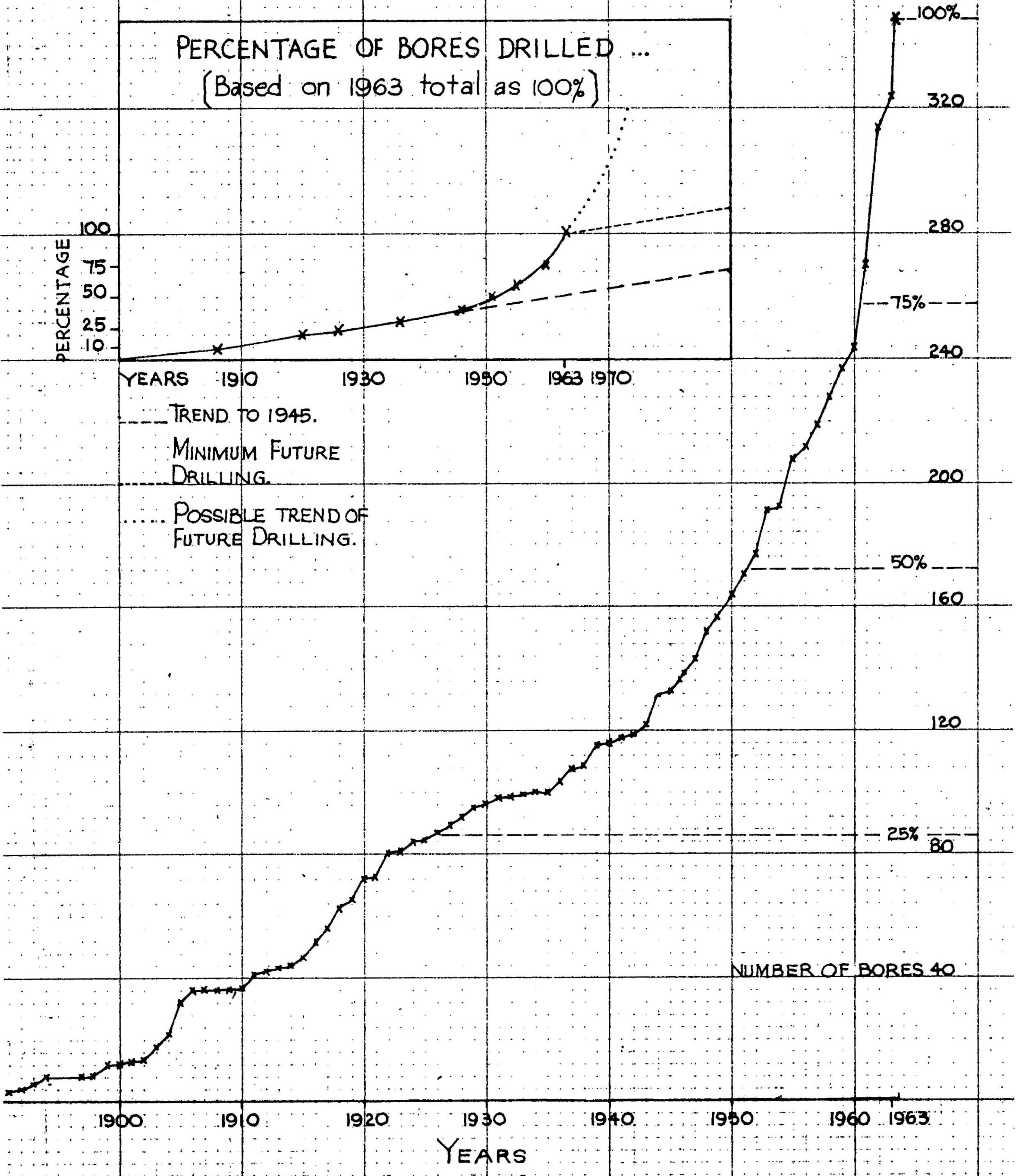
In the period 1915 to 1920, 25 bores were drilled in the area; much of this activity may have been due to the lessons learned during the very dry period 1911 to 1916 in which thousands of head of stock perished.

About 1920 Alroy Downs drilled six successful bores. In the same

Figure 5

PROGRESSIVE TOTAL OF WATER-BORES DRILLED..

BASED ON 348 BORES



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year bores were drilled on Brunette Downs and Rocklands. During the decade 1920-1930 drilling continued byt the initial effects of the depression and events leading up to it became apparent (Fig. 5a & b). Bores were drilled on Alroy Downs, Anthony Lagoon, Brunette Downs; renewed activity occurred on Avon Downs and in 1929 the Ranken Plain Bore (R.N. 534) was drilled on the Barkly Stock Route. This was followed by Connells Lagoon Bore (R.N. 531) in 1930. These were the first bores drilled on the Barkly Stock Route east of Anthony Lagoon Homestead, and the sites had been selected by Keith Ward (1926) some years earlier. Ward (op. cit.) records that the Barkly Stock Route had been in existence for some years and water for travelling stock could be obtained at fixed charges from private bores - notably Bluebush and Anthony Lagoon, Armchair (No. 8) and Crows Nest (No. 14) Bores on Brunette Downs, and Alexandria No. 1.

The effects of the depression are apparent in the period 1930 to 1935; records can be located for only three bores - Connell's Lagoon Bore and two bores on Brunette Downs. Drilling increased immediately before the war, the main contributors being Anthony Lagoon and Brunette Downs; a government bore was drilled at Ranken and the Ranken Plain bore was re-drilled. The last bore drilled before the full impact of the war appears to be Yellow Hole (R.N. 776) on Austral Downs.

The war years 1940 - 1945 saw very little private drilling on the Tableland, but the incidence of drilling was maintained by the construction of numerous bores along the Barkly Highway for use by gangs engaged in its construction and by defence personnel in transit. Wendy, O'Reilly, and Desert were drilled on the Barkly Stock Route during this period. The only private bores which can be traced for this period are Alroy Downs bores Nos. 15 (R.N. 733) and 16[+] (R.N. 734).

Immediately after the war (late 1945) drilling resumed on Brunette Downs which in the period 1945 to 1950 drilled about ten bores. In the same period ten bores were drilled on the Barkly Stock Route between Anthony Lagoon and Camooweal Township; this gave travelling stock watering points less than 18 miles apart. The post-war period saw renewed activity on Alexandria which in 1946 drilled its first bore since 1919; this station has drilled the second

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[+] Now South Barkly Stock Route No. 3

largest number of bores in the region since the war. Anthony Lagoon recommenced drilling in 1947; and Rockhampton Downs[+] No. 5 was drilled in 1948.

By 1950 two hundred bores had been drilled on the Barkly Tableland, but a spectacular expansion was yet to come. From the beginning of 1950 to the end of 1959, at least 80 bores were drilled in the region and from 1960 to mid-1963 an additional 106 have been drilled. Maximum activity in the period 1950-1959 was on Brunette Downs (30 bores)followed by Alexandria (21 bores); drilling was also done on Alroy, Anthony Lagoon, Austral Downs, and Avon Downs. During 1954 and 1955 eight Government bores were drilled along the South Barkly Stock Route. No. 3 Bore on this Stock Route was drilled in 1944 as the original Alroy Downs No. 16 Bore.

By far the most active station in the region since the beginning of 1960 to the present has been Brunette Downs, which has drilled over 70 bores in this period; Alexandria has drilled about eight in the same time. In this period some drilling was done on Alroy and Anthony Lagoon, and four bores - Nos. 30 - 33 were drilled in Rockhampton Downs. In 1961, nine bores - Nos. 13 to 18, Kelly Bore, and two dry holes which were not numbered were drilled on Creswell Downs. The dates of drilling for Creswell Nos. 1 - 12 have not been traced, but some of these bores were in existence in 1947 and all were in existence by 1957.

Present Bore Density and Future Development

During the 1961/62 geological survey of the Barkly Tableland the Bureau of Mineral Resources located 447 bores in the area covered by this report. Eighty-six of these bores have never been equipped or have been abandoned after some time in use for the following reasons:

Dry Holes	4	
Poor supply:	6	
Poor quality:	9	
Collapse of casing:	15	
Silting:	5	
Not required/Temporary shut-down	18	
Drilling difficulties	9	
Reasons unknown: (But not dry)	20	
	86	(19%)

[+] No information is available for Rockhampton Downs Nos. 1 - 4 and 6 - 29.

The table shows that the incidence of total failure to obtain water is low; the chances of not finding usable water in sufficient supply are less than 5 percent. It should be noted that decisions on whether a supply is sufficient, or of reasonable quality, are often subjective. Some stations may not equip a bore of certain salinity but other stations will equip a bore of even higher salinity. This practice is declining as now pastoralists usually forward a water sample for analysis to the Animal Industry Branch at Alice Springs or Darwin whose recommendations are usually, but not always, followed. Some pastoralists will not equip a bore which will produce less than 1500 gallons per hour but others consider 1000 gallons per hour adequate.

There are over 360 working bores in the area of this report, representing a bore density of about one bore per 100 square miles, but this figure includes stock route bores and miscellaneous government bores, and the area includes tracts of unleased land; the average bore density of the pastoral holdings is approximately one bore per 84 square miles. (Table 2).

Table 2: Bore Density - Barkly Tableland

Station	Approx. area in sq. miles	No. of Working Bores	Average area served per bore (sq. mls)	+No. of bores below maximum density (approx)
Alexandria	8200	48	170	157
Alroy	1550	25	60	14
Anthony Lagoon	2400	24	100	36
Austral Downs	1620	16	100	24
Avon Downs	1430	16	90	20
Brunette Downs	4730	119	40	-
Creswell	2000	21	100	29
Dalmore Downs	1260	13	100	18
Rockhampton Downs	2000	33	60	17
Rocklands	1400	12	120	23
Total pastoral leases	26,600	327	84	338

+ Based on present maximum density of 1 bore/40 square miles on Brunette Downs.

The maximum density of bores on the private holdings is one bore per 40 square miles on Brunette Downs Station. This station has in recent years carried out an extensive development programme associated with the importation of Santa Gertruda cattle. According to the station people the ultimate aim is to have in some areas bores no more than five miles apart, i.e. about one bore per 25 square miles. If this bore density proves to be efficient other stations may follow this example and increased drilling may be expected. The last column of Table 2 shows the number of bores required on each station to give the same bore density as at present on Brunette Downs. To achieve this density for the region as a whole, double the present number of producing bores is required. Such an expansion is controlled by many economic factors not the least of which is available capital for major property improvements.

Kelly (1963) considers the Barkly Tableland has some potential for cattle fattening; if fattening is carried out in addition to breeding, a great many bores will be needed on the majority of holdings. Figure 5 shows the progressive bore totals since drilling commenced in 1890 to mid-1963; figure 5b shows these totals converted to percentages of the mid-1963 total. The development to about 1945 is essentially linear, but since then has risen sharply. If the present trend continues at least 150 additional bores will be drilled in the region by 1970.

OCCURRENCE

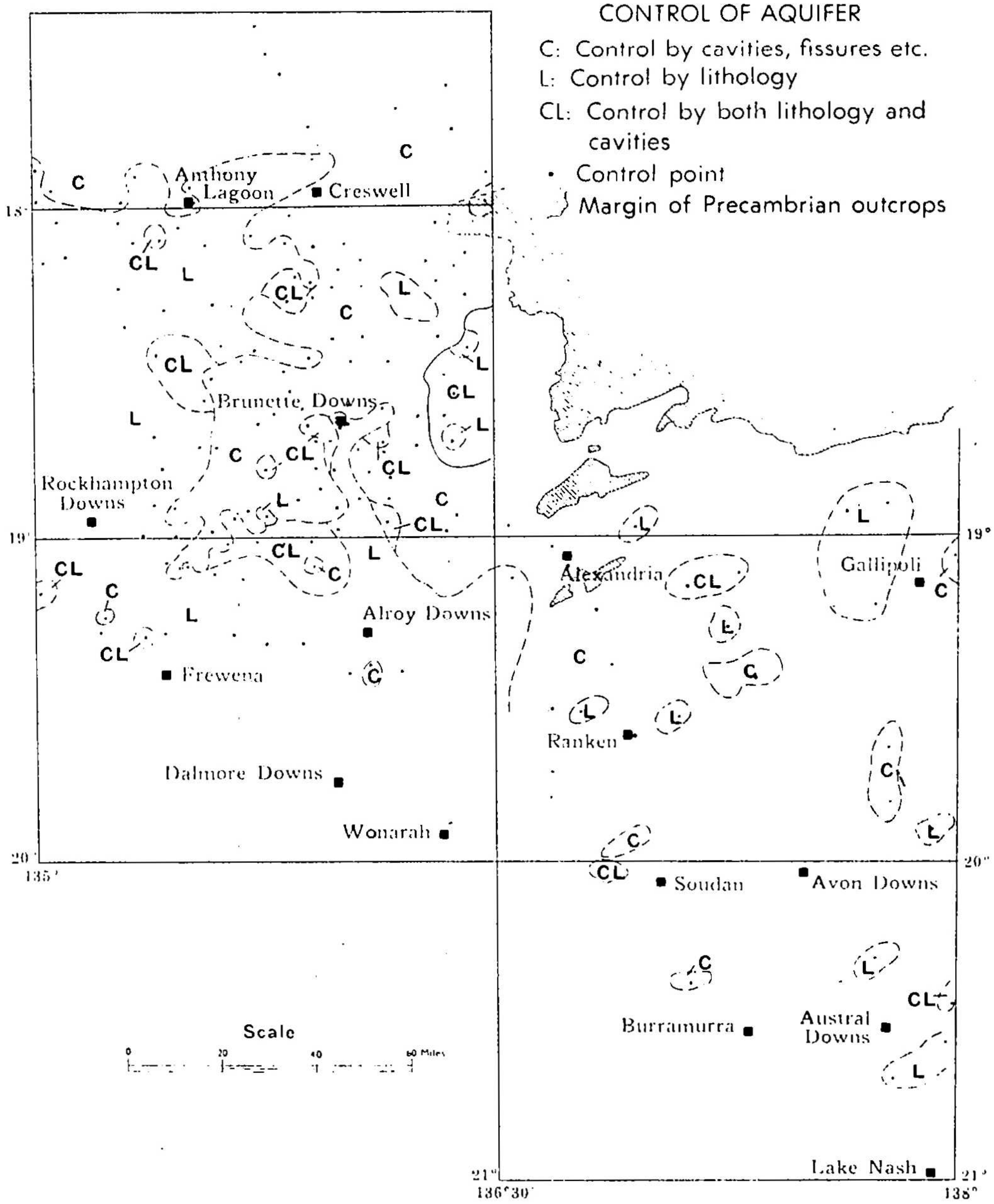
Aquifers

Most bores in this part of the Barkly Tableland obtain groundwater from the Cambrian carbonate sequence. There is no evidence of aquifers in either the Mesozoic rocks in the north or the Tertiary limestones in the central and southern parts of the region. Where bores have been spudded into these younger rocks the aquifers recorded are far deeper than the probable base of these younger sediments, which may however permit the passage of water from the surface into the older rocks. Noakes (1954) believes that 'water has been drawn from these limestones (i.e. the Tertiary limestones) in the Georgina Valley (further south) but probably not in the Barkly Basin'. Further north on the Beetaloo Sheet area groundwater is obtained from the Mesozoic rocks which are much thicker than in this region (Randal, Brown, & Doutch, in prep.).

Only a few bores are drawing water from aquifers within the Adelaidean Mittiebah Sandstone. Five bores have definitely penetrated this unit: one, near Alexandria aerodrome, was completely dry; the drillers log for another indicates no aquifer other than one in the Cambrian sequence many hundreds of

Figure 6

WATER BORES STUDY
BARKLY TABLELAND



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feet higher in the hole (Alexandria No. 1, R.N. 735); but two others, Creswell Downs Nos. 14 and 16 (Reg. Nos. 2746, 2749), obtain supplies of 1300 and 4000 g.p.h. respectively from 'cavities' in a hard red sandstone. Chips from these two bores have been examined and are identical to the Mittiebah Sandstone which crops out nearby. An unsuccessful bore (R.N. 2747) in the Calvert Hills Sheet area, which has not been included in this survey, also penetrated the Mittiebah Sandstone: it obtained only 60 g.p.h. of very salty water from the overlying limestone and 'clay' sequence.

The piezometric surface in the north-eastern part of the region slopes away from the Proterozoic outcrops, suggesting they are at or near an intake area for the groundwater system. Water may be taken in along the Cambrian/Precambrian boundary and thence pass into aquifers in the Cambrian sequence which abut against the unconformity, rather than into the Mittiebah Sandstone itself which appears to have lower permeability.

The drillers logs and the position and total depth of the remaining bores in the region indicate that the aquifers are in a mainly carbonate sequence. Plates 3a, b, c and d illustrate graphic logs of selected bores, based on a free interpretation of the drillers' rock terms. The incidence of mainly carbonate rocks at depth is obvious, but the graphic logs also indicate that there is a greater variation in rock type in some areas than in others. In most of the Ranken and parts of the Avon Downs Sheet areas the logs indicate mainly 'limestone' and ribbonstone or flints. This can be interpreted as the chert-bearing Camooweal Dolomite which contains very minor interbeds of other rock types. Similarly little variation is obvious in the individual bores in the north-eastern part of the Alroy Sheet area, and in the eastern and north-eastern parts of the Brunette Downs Sheet area. On the other hand, considerable variation in rock types occurs in the bores in the western part of the region. There the drillers' logs indicate considerable amounts of sandstone and siltstone in the carbonate sequence. In many cases the producing aquifer is sandstone or 'porous' limestone overlain by siltstone or tight hard limestone. The drillers' logs of the water-bores frequently refer to caves, cavities, and fissures in the limestone parts of the sequence. Figure 6 is a diagrammatic interpretation from the drillers' logs showing the areas where the occurrence of groundwater is controlled by i) cavities etc., ii) lithological control, and iii) a combination of both. The main boundary between the areas of lithological control in the west and cavities in the north-east and east may in time prove to approximate the change in the subsurface of the mainly dolomitic carbonate rocks in the east to the more varied rocks in the west. An interesting point on the incidence of cavities on the Barkly Tableland is the fact that several stratigraphic wells drilled in the region have experienced lost circulation.

Two hundred and twenty nine of the driller's logs record the depth to the aquifers (Appendix B): 85 record one aquifer, 110 two aquifers, 31 three aquifers, and only 3 record four aquifers. However BMR 11 (Cattle Creek) intersected five aquifers between 320 and 525 feet (Johnson, Nichols & Bell, 1964). Severe losses of circulation from 525 feet to the total depth indicate additional aquifers (K.G. Smith, pers. comm.).

Clearly the Cambrian carbonates contain numerous aquifers, but it is impossible to determine how many as the aquifers cannot be correlated from one bore to the next: rock chips from only a few water-bores have been examined by geologists and the few stratigraphic holes are too far apart to permit interpolation of data. It is not known if the individual water-bores are penetrating the same intervals of the Cambrian sequence - locally they may be but regionally probably not. It is possible that for some bores, all the aquifers penetrated have not been detected or even recorded.

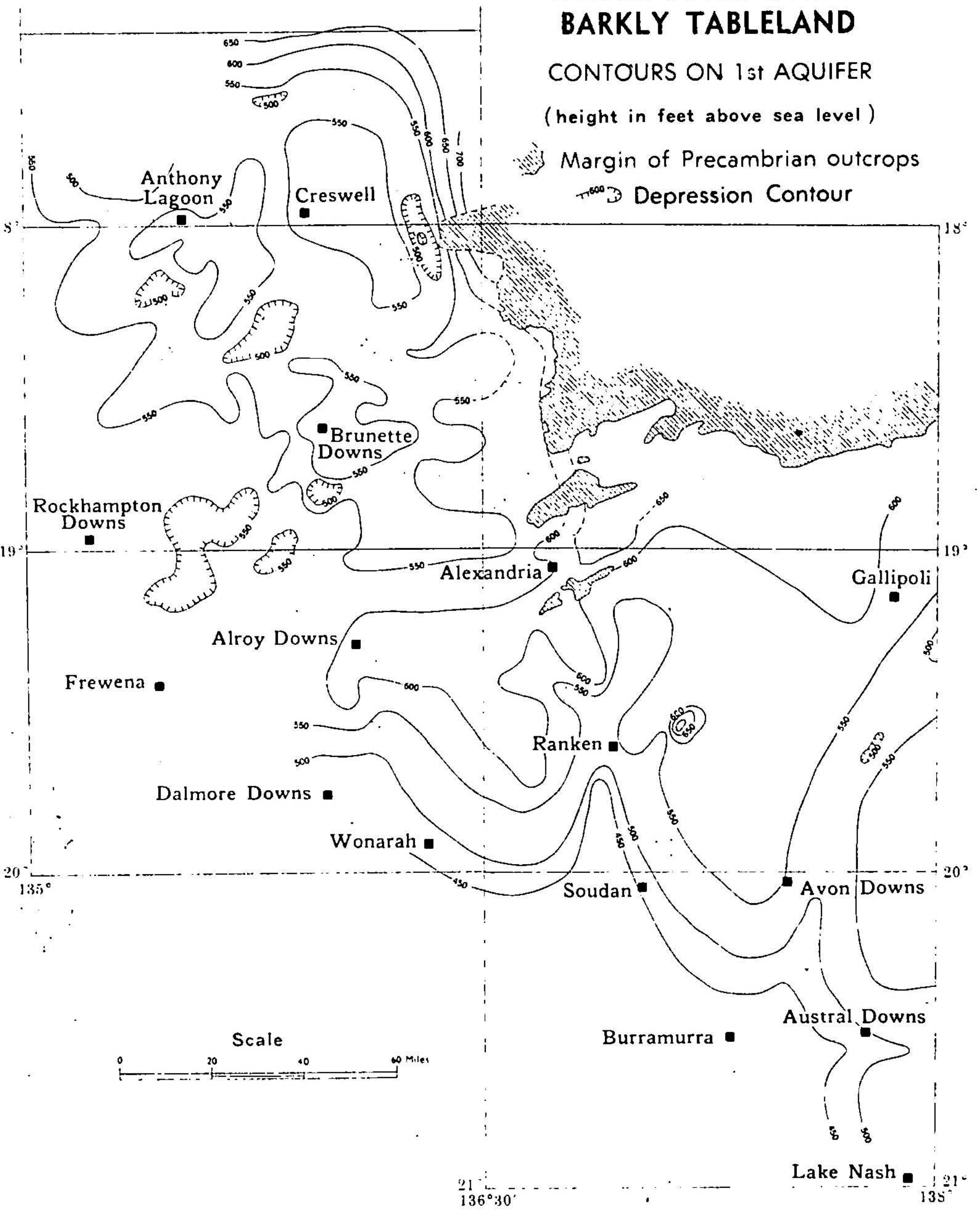
The supply from the first encountered aquifer in some bores was inadequate and drilling continued until a deeper aquifer giving a sufficient supply was intersected. The poor supply from the shallow aquifers is presumably caused by low permeability and a lack of available draw-down, i.e. the aquifer is at or close to the piezometric surface. If the geological structure takes the shallow aquifer well below the piezometric surface the aquifer may yield an improved supply, particularly if there is also an increase in permeability. At the position where the aquifer gives a higher yield it may or may not be the first aquifer encountered: furthermore the increase in supply may be accompanied by an increase in salinity because at that position the aquifer is further into the geological structure. But the drillers' logs and the pastoralists frequently report that the first encountered aquifer produces much less saline water than the deeper ones, and there must be a position where a compromise between reasonable salinity and reasonable supply can be obtained. This situation may be important if better quality

Figure 7

WATER BORES STUDY BARKLY TABLELAND

CONTOURS ON 1st AQUIFER

(height in feet above sea level)



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water than is at present being obtained is required for domestic and agricultural purposes. Unfortunately little is known about the chemistry of the groundwater in the first encountered aquifers as samples are never collected if the supply is low. The presence of several aquifers, lack of correlation, and interconnexion between aquifers makes the study of the groundwater distribution complicated and difficult. But some efforts should be made to assess the availability of the reputedly good quality water.

The depth to the main aquifer (which is sometimes the same as the first) is the depth at which the incidence of cavities and fracturing, or the porosity, is high enough for the accumulation of exploitable quantities of water. Therefore, although contours on these depths may not necessarily represent structure contours, the surfaces they define do have some hydrological significance.

Figure 7 illustrates contours on the depths of the first aquifers converted to heights above sea-level. The elevation of this surface varies from 700 feet east of Creswell Downs Homestead and near Ranken Store to below 450 feet in the southern part of the region. A zone of high contours south-west of Alexandria Homestead tends to divide the region into two areas: one to the south-east and east where the regional slope forms a complex basin, with high areas, and then declines north-westerly. The zone is concordant in trend with that of the inlier of Mittiebah Sandstone near Alexandria, and broadly conforms to a hydraulic divide evident in the piezometric surface and several of the chemical characteristics of the groundwater.

Figure 8 and Plate 4 illustrate the surface of a hypothetical aquifer based on the height above sea-level of the main aquifer encountered in 229 bores. There is no stratigraphic correlation between bores, and the position of the main aquifer is a subjective determination by pastoralist of driller on what is an adequate supply. However, in areas of high bore density, adjacent bores may be drawing their supplies from the same aquifer, and therefore the contours on the aquifer may locally represent structure contours.

The contours on the hypothetical aquifer have some definite use for the development of the area insofar as they give some indication of the depth at which adequate water supplies may be obtained.

Despite the limitations of the contour map, some interesting and speculative observations can be made. The contours agree regionally with those on the first aquifer. There is a definite division of the region into two areas - one in the south-east, and one in the north-west. However, the ridge between the two is not well-defined: it extends from Alroy Downs to near Alexandria Homesteads, but only vaguely conforms to the piezometric and chemical zones of demarcation.

Supply

The supply of groundwater from the majority of the bores drilled in the region is generally adequate. Two hundred and seventy-one bore-logs record the supply, and the frequency of various ranges of supply is shown below:

Supply	No. of bores
500 gallons per hour	6
500-1000	15
1000-1500	47
1500-2000	107
2000-2500	40
2500-3000	37
3000 or more	19

Clearly 75 percent of the bores are capable of producing in excess of 1500 g.p.h. which is regarded as adequate to warrant equipping. The decision on whether a supply is adequate or not is commonly subjective, and some pastoralists will equip a bore producing considerably less than 1500 g.p.h. The requirements for purely domestic purposes are less, but the quality of the supply is important, and this is discussed in some detail in a later chapter.

It has not been possible to relate the availability of groundwater to any particular Cambrian unit because of the inadequacies of the bore-logs, and the manner in which the supply is measured and recorded. Some of the yields recorded are the limits of the pumping equipment in use at the time the bore was constructed: it is possible to note a steady increase in the supply quoted in the logs from the start of the early drilling to the present day. Some logs give no indication of the supply, and some merely state 'good, poor or fair'. In some instances the supply is an estimate only and has not been adequately measured. Certainly there has been very little recorded of the most important variables associated with supply, viz. drawdown and recovery time. On the first test, if the supply is regarded as inadequate, the pump

Figure 8

WATER BORES STUDY
BARKLY TABLELAND

CONTOURS ON HYPOTHETICAL AQUIFER

elevations in feet above sea level

To accompany Record 1966/11

will be lowered and a further 'pumping-test' carried out. Should the supply then be 'adequate' for a few hours, the test is completed, and ultimately permanent pumping equipment erected over the bore, with the risk of later forking and possible damage owing to sanding or silting. This may be accompanied by damage to the aquifer. Very few pumping tests are continued long enough to indicate the safe yield; many underestimate the potential of the bore, and a few probably overestimate what is a safe yield. The latter situation is probably not a problem in the case of engine-driven pumps where greater control over the rate of pumping is available, but it is a definite hazard with wind driven pumps which are left unattended for long periods in conditions of sustained high winds; frequently smaller mills or pumps are used to reduce the risk. The amount of time that can be used for pumping tests is limited by many factors, and the present practice of quick tests, though undesirable, is usually adequate for this region where supplies are generally assured. However, should an intensive drilling programme be required in this region for future closer settlement, careful pumping tests must be conducted. This need will assume great importance if the reputedly better quality water of shallow aquifers is utilized.

The supply/drawdown ratio i.e. the yield per foot of drawdown under test, has been calculated for 108 bores, and the results plotted but not illustrated here. Because no figures for different pump positions for the same bore are available, because the supply quoted in the logs is sometimes misleading, and because the ratio has been calculated in most instances on the maximum possible drawdown (i.e. standing water level minus pump depth) only general inferences can be drawn. Most of the values obtained are minimum ones.

The value of the ratio ranges from less than 20 gals/ft to over 660 gals/ft. Values greater than 100 gals/ft occur in the area from the headwaters of Desert Creek north-eastwards to Buchanan Creek, thence along the Playford valley to Lake Sylvester and northwards to Boree Creek. High values occur in the area of the Camooweal Dolomite bounded by the upper reaches of Buchanan Creek, Six Mile Creek, and Gallipoli Homestead; they also occur in small areas along Lignum Creek to Tarrabool Lake, east of Creswell Downs Homestead, east of Rockhampton Downs Homestead, and in a narrow belt from Corella Creek through Brunette Downs Homestead to Mittiebah Creek. All these areas of high values are ringed by bores for which the ratio lies between 50 and 100 gals/ft. Values of less than 50 gals/ft occur between Creswell and Fish-Hole Creeks, near Alexandria Homestead, between Wonarah and the north-western part of the Alroy Sheet area, south of Anthony Lagoon Homestead, and around Lakes Corella and Sylvester.

There is a very general relationship between this ratio and the direction of groundwater flow: low values occur in areas near recharge, higher values occur in areas of accumulation indicated by the piezometric surface. The ratio also tends to be high in the areas where drillers' logs indicate cavities and fissures, but again the relationship is not an exact one. The ratio could be used to learn much about the permeability of the aquifers but until it can be accurately determined no detailed interpretation can be made.

HYDRODYNAMICS

PIEZOMETRIC SURFACE

The standing water levels have been converted to heights above sea-level and contoured to produce the piezometric surface (Pl. 5 and Fig. 9). Water does not normally occur at this surface until an underlying aquifer has been penetrated. As outlined earlier there are several aquifers within the Cambrian carbonate sequence, and therefore the surface illustrated in Figure 9 refers to the piezometric surface of an aquifer system, rather than a single discrete aquifer. Because the drillers' logs rarely record the standing water levels for the separate aquifers in each bore it is impossible to evaluate the various components of the composite piezometric surface. This is also prevented by the lack of reliable correlation between the aquifers of adjacent bores. In some instances the surface is a simple one as it is sometimes coincident with the first encountered aquifer.

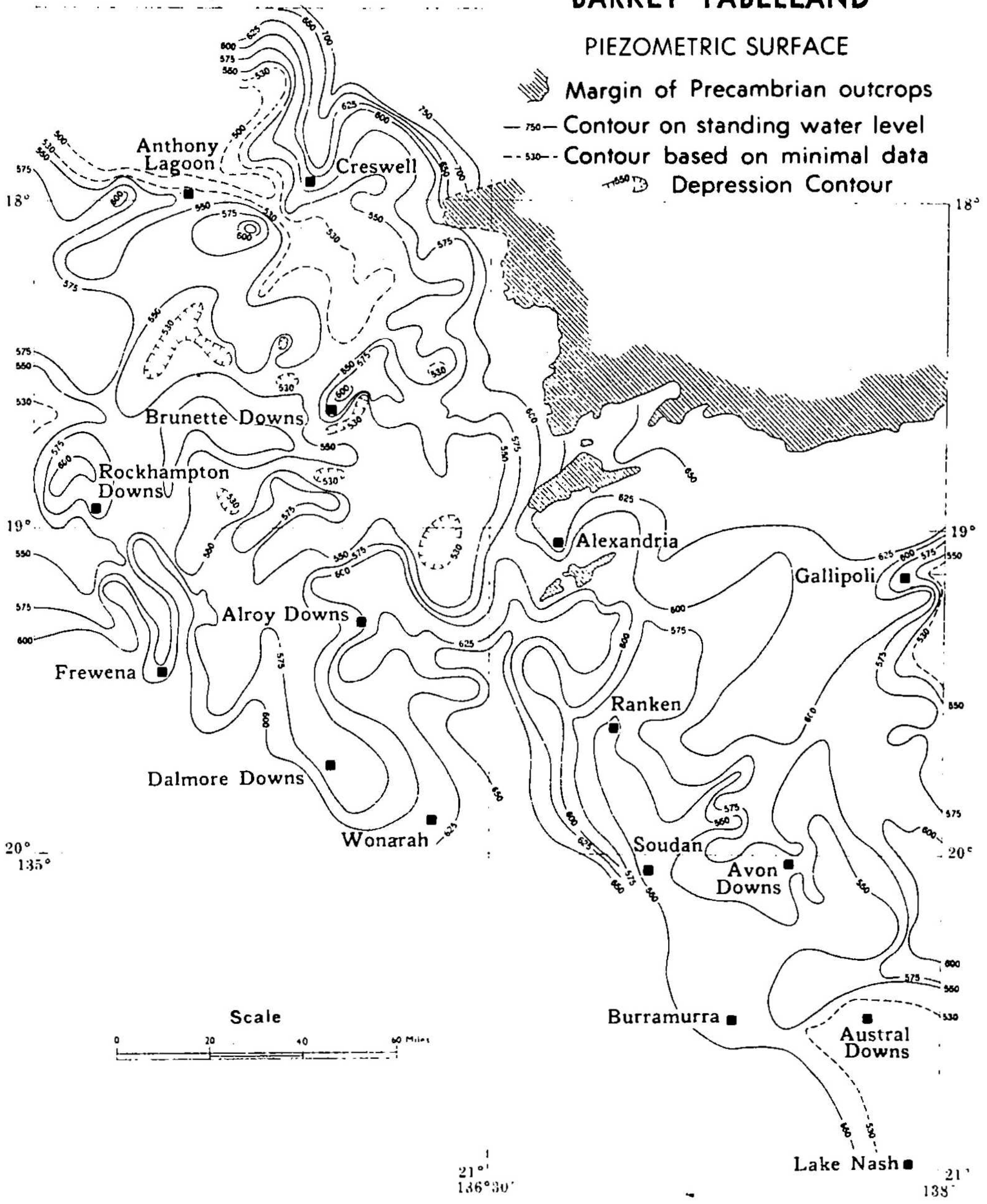
In twelve widely separated bores small amounts of water were encountered at a depth above the standing water level for the subsequent aquifers. These bores are apparently isolated cases where minor accumulations of water occur in small systems with no connexion whatever with the main groundwater body. They are not further discussed.

The water in the main groundwater system is mostly confined i.e. once an aquifer has been intersected the water rises in the bore. None of the aquifers is artesian but most are subartesian: the water does not rise to the

Figure 9

WATER BORES STUDY BARKLY TABLELAND

PIEZOMETRIC SURFACE



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ground surface as the piezometric surface lies below the ground surface throughout the region. Table 3 illustrates the amount of the rise in 193 bores: it gives the minimum rise i.e. the difference between the standing water level and the depth of the first aquifer.

Table 3 Frequency distribution: height of standing water above first aquifers.

Height	number of bores	percentage
Nil (no rise)	65	34
1 - 10 feet	45	66
11 - 20 "	31	
21 - 30 "	19	
31 - 40 "	11	
41 - 50 "	5	
51 -100 "	9	
101 -151 "	4	
greater than 150 feet	4	
Total	193	100

Of the 65 bores in which the standing water level and the first aquifer are co-incident, only eleven obtain adequate supplies from the first aquifer: the other 54 were drilled deeper to obtain adequate supplies of confined water. The former are cases where the permeability is high enough to offset the lack of available drawdown. One hundred and twenty-eight bores intersected confined water in all aquifers.

The regional piezometric surface broadly reflects the physiographic divisions of the region. A zone of high standing water levels outlined by the 600 foot contour extends from east of Alexandria Homestead to near Wonarah and corresponds to the surface divide of the physiographic units. It divides the groundwater system of the region into two sub-basins - one co-extensive with the Barkly Internal Drainage Basin and called the Central Basin, and one co-extensive with the Georgina River Basin and called the South-eastern Basin.

It is not suggested that the groundwater system and the surface drainage systems are intimately connected. There is evidence they are not: bores near or along water-courses do not necessarily obtain supplies at shallower depths than other bores, and the piezometric surface is not a water table. It is alternatively considered that the regional geological structure affects both systems in different ways. The geological setting has moulded the physiography, and has also influenced the configuration of the piezometric surface by its control on the distribution of aquifers and recharge areas.

The Central Basin is outlined by the 575-foot contour in the north-west, the 600-foot contour in the south and east, and the 625-foot contour in the north-east. In addition the piezometric surface reaches an elevation of 750 feet in a small area in the north-east, and 670 feet near Desert Creek in the south-east. The Central Basin may be connected to another two sub-basins - one to the north of Anthony Lagoon Homestead, and one to the west of Rockhampton Downs Homestead - but the study outside this region is not complete and little is known of the groundwater environment in the adjoining areas.

The South-eastern Basin is outlined by the 650-foot contour in the west, the 600-foot contour in the north-west, and the 625-foot contour, and Precambrian rocks in the north. It extends southwards beyond the margin of the region. It has not been traced to the east although preliminary work indicates its existence in the western part of the Camooweal Sheet area (Opik, Carter, & Randal, in prep.), and to the north-east it appears to be connected to a sub-basin coincident with the surface drainage area of the Gregory River.

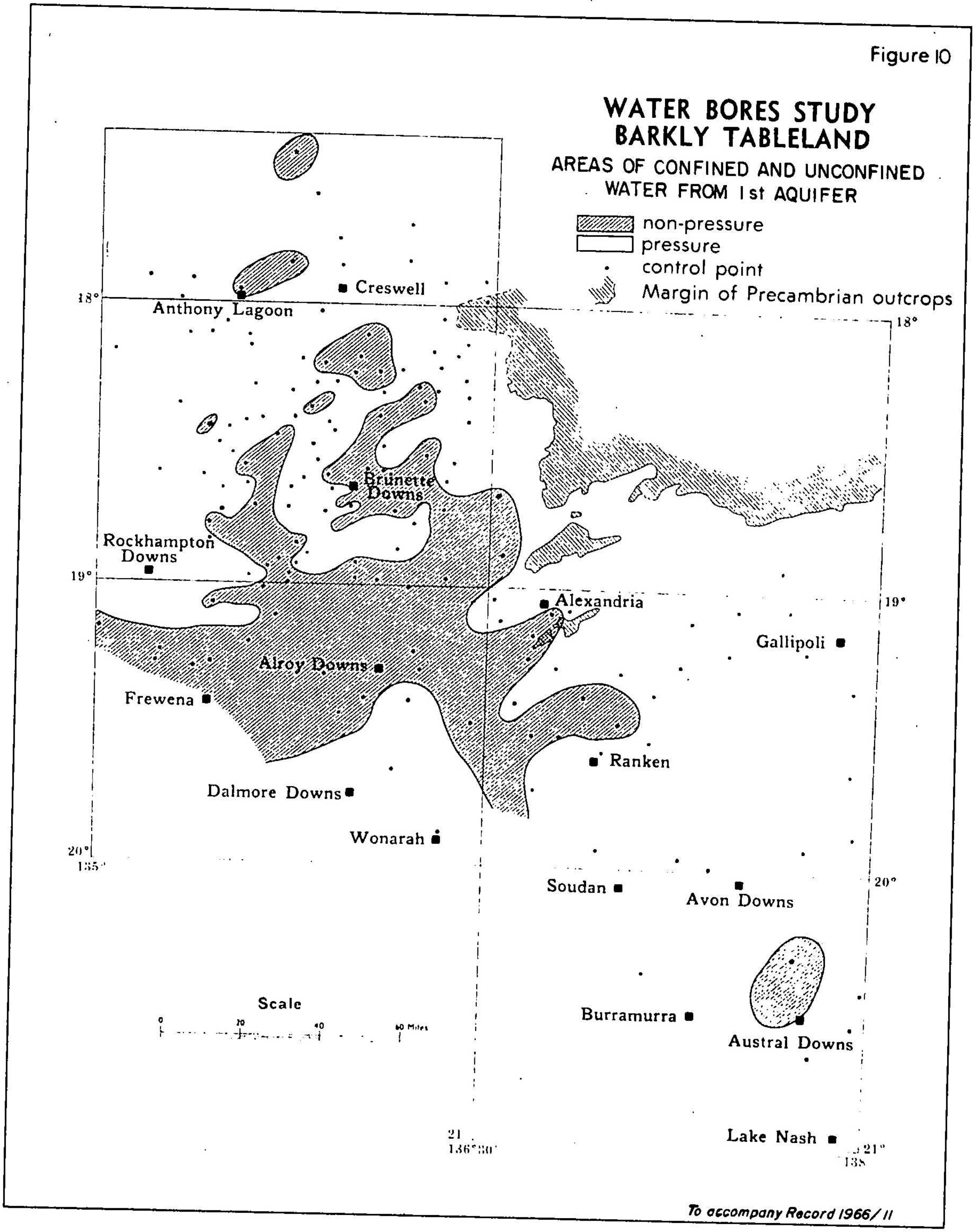
The division of the groundwater system into two basins is supported by the discussion on the geochemistry of the groundwater, in particular the salinity (p.42), the chloride ion content (p.51), the ionic ratios (p.61), and the chemical types (p.65).

GROUNDWATER MOVEMENT

Regional

It is easier to determine the regional directions of groundwater flow into the Central and South-eastern Basins than it is to ascertain the directions of flow within them. This is particularly so in the case of the Central Basin where the hydraulic gradients appear to be low. As discussed earlier accurate elevations on the bores are not available and this prevents the determination of accurate elevations on the standing water levels and hence detailed contours for the piezometric surface. However the variation

Figure 10



WATER BORES STUDY
BARKLY TABLELAND

AREAS OF CONFINED AND UNCONFINED WATER FROM 1st AQUIFER

To accompany Record 1966/11

in the elevation of the piezometric surface from the margins of the basins to the lowest points is very much larger than the expected errors caused by inaccurate data. It is assumed that groundwater flow is at right angles to the piezometric form lines and in the direction of decreasing elevation of the piezometric surface.

The direction of groundwater flow in the Central Basin is generally towards the centre of the basin with outlets to the north-west and west. The piezometric surface declines westward from the areas of Precambrian rocks in the east, and northwards from the desert areas to the south and south-west. The piezometric form lines in the north-west indicate groundwater movement mainly to the east with some flow to the north and south-west. Within the basin movement is mainly directed towards an arcuate elongated area which extends from Anthony Lagoon Homestead to Brunette Downs Homestead and thence south-eastwards to midway between Alroy Downs and Alexandria Homestead. This area is outlined by a trough in the piezometric surface which is shown by the 550-foot contour: it has two smaller troughs extending westward from it, one north-west and one south-west of Brunette Downs Homestead. The 530-foot and 500-foot contours indicate the main trough is open to the north, but within it the 530-foot contour is closed north-east of Alroy Downs Homestead and in several places near Brunette Downs Homestead. The main trough and in particular the areas of closure are where the water is the most saline (p.44; Fig. 11).

The piezometric surface is at its lowest elevation - 500 feet - to the north of Anthony Lagoon Homestead. The gradients here indicate water movement to the north away from the main part of the Central Basin, and the contours here may represent the southern margin of a groundwater basin to the north-west. Similarly the 530-foot contour north-west of Rockhampton Downs Homestead may indicate the presence of another basin to the west of the region.

The regional direction of groundwater movement into the South-eastern Basin is eastward from the desert country near Wonarah in the west, south-eastward from north of Ranken store, and southward from the Precambrian rocks in the north. The main direction of flow within the basin is directed southwards: this is also the general direction of increasing salinity. The South-eastern Basin extends on to the Camooweal Sheet area where it has not yet been defined.

Interconnexion

The logs of 65 bores indicate that the piezometroc surface lies at the level of the first aquifer i.e. the first aquifer appears to contain unconfined water (Fig. 10) Noakes (1954) referred to the bores in which no rise of water level occurred: these totalled twenty percent of the bores for which logs were then available. He considered these cases 'indicate the existence of groundwater+, but this percentage is less significant than it seems because no less than 16 of the 28 bores which show no rise are situated in one relatively small area on Alroy Station'. Extensive drilling since 1947 shows the area to be much larger than Noakes originally thought, although it is centred about the Alroy area (Fig.10). Despite the large size of this area of apparently unconfined conditions it contains no anomalies either in the piezometric surface or, as shown later, in the chemical characteristics of the groundwater relative to the areas of proved confined conditions, i.e. it appears to be continuous with the groundwater system over the rest of the Barkly Tableland. Even though the standing water level in this area appears to be a water table the existence of confined water is still apparent as in 54 bores there was a rise of water above the deeper aquifers (p.33). The bores simply may be cases where the confined water of the deeper aquifers has been able to adjust to the level of the regional piezometric surface by leakage upward through joints, fissures, and cavities. Leakage may also occur slowly across confining beds of some-albeit low - permeability, and also quickly across such confining beds if slight facies changes cause an increase in permeability. If the permeability of the beds which occur at the level of the piezometric surface is high and if the interconnecting paths between them and the deeper aquifers are large enough the bore may produce an adequate supply.

Interconnexion is also evident in some bores where the standing water level is above the level of the first recorded aquifer: for these the logs indicate that the standing water level is the same for the various aquifers encountered. In these cases confining beds overlying the first recorded aquifer have prevented the groundwater from fully adjusting to the regional

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+ Groundwater in the context used by Noakes referred to unconfined water.

Figure 11

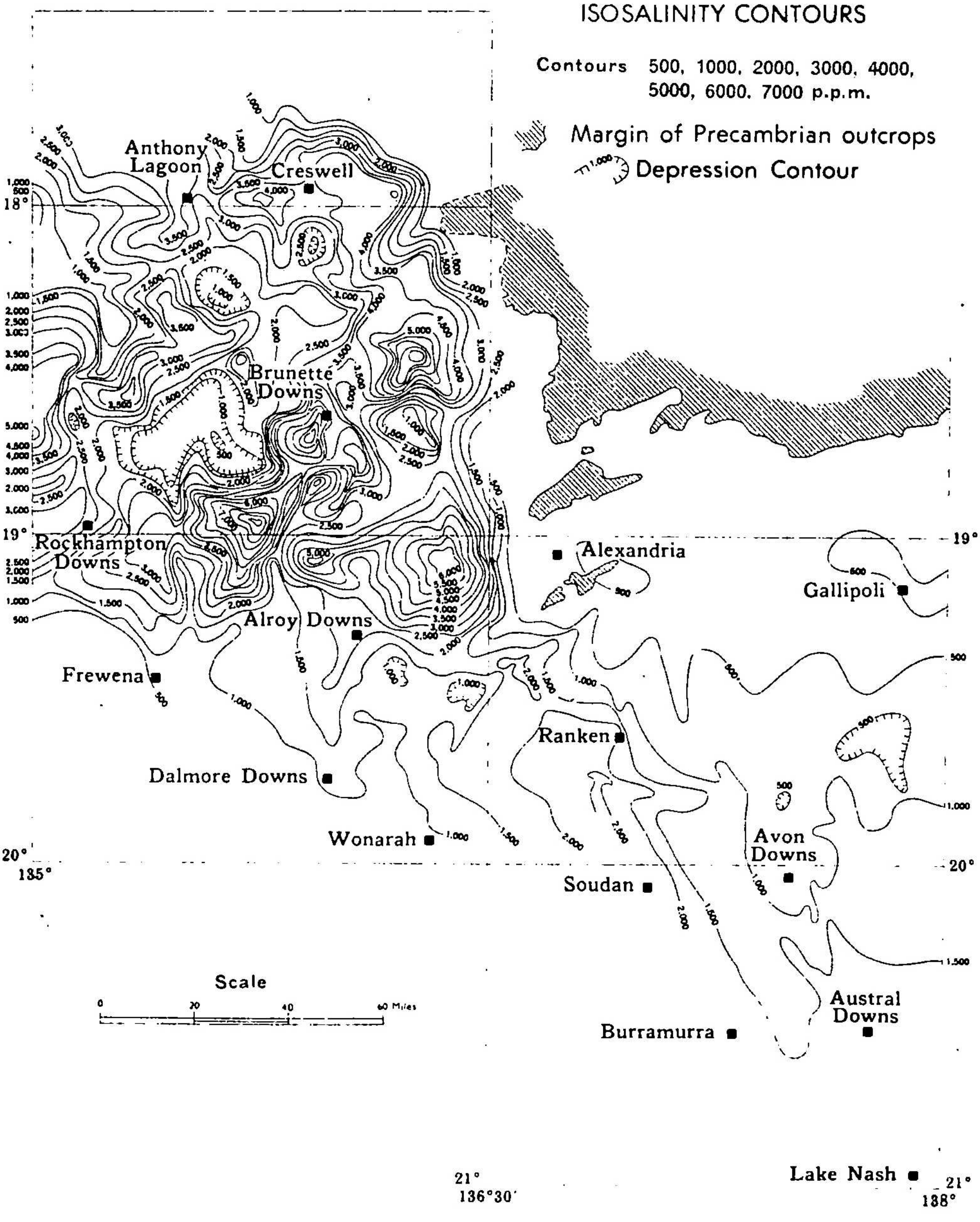
WATER BORES STUDY
BARKLY TABLELAND

ISOSALINITY CONTOURS

Contours 500, 1000, 2000, 3000, 4000,
5000, 6000, 7000 p.p.m.

▨ Margin of Precambrian outcrops

Depression Contour



To accompany Record 1966/11

piezometric surface.

A good example of interconnexion is afforded by the stratigraphic well BMR 11 (Cattle Creek) in the eastern part of the region. This well which was air-drilled to 525 feet, penetrated aquifers at 220-230, 280-290, 320-370, 415-425, and 515-525 feet. The following is a resume of the hydrological behaviour of the well (K.G. Smith, BMR., pers. comm.). At 360 feet the water supply was tested at 6000 gallons per hour, and because of difficulty in maintaining circulation against the hydrostatic head (S.W.L. was 191 feet) casing was run at 410 feet. The casing shoe was drilled out and at 415 feet 300 gallons an hour was lifted. At 423 feet the supply was tested at 2000 gallons per hour, at 428 feet tested at 4000 gallons per hour, and at 450 feet tested at 5000 gallons per hour. The hole was cement plugged from 460 feet to above the casing shoe, and on redrilling the hole produced 300 gallons an hour above 460 feet. At 490 feet it was tested and produced 1500 gallons per hour, 504 feet 1800 gallons per hour, and at 521 feet 3000 gallons per hour. The hydrostatic head was too great for further air-drilling, and as mud was used no information on supplies below 525 feet are available. But extensive lost circulation in the deeper parts of the well indicates that aquifers are present. The standing water level for all aquifers was 191 feet, and although no drawdown figures were measurable Smith reports recovery was rapid.

Interconnexion is suggested by the closed contours on the lowest levels (530 feet) of the piezometric surface in the Central Basin. The closures may indicate hydrodynamic sinks caused by water passing from one aquifer system into a deeper one i.e. interconnexion. However, as discussed earlier the piezometric surface is a composite one, and the closure may be caused by the absence of the higher parts of the aquifer system which elsewhere contribute a component to the piezometric surface.

The chemistry of the groundwater shows that the groundwater attains its highest salinity at or close to the areas of closure, and the areas of low piezometric surface. The probability of interconnexion warrants a careful study of the conditions of storage and availability of the reputedly good water in the higher aquifers if this water is exploited: the interconnexion may permit movement of the saline groundwater into the higher parts of the groundwater body if the withdrawal is excessive.

RECHARGE

Recharge in the Central Basin appears to be from the desert country to the south, the ridges of Precambrian rocks to the east and north-east, and from small areas within the basin. The small areas are indicated by the closure of high value contours in the following places: south of Anthony Lagoon Homestead, north-east of Brunette Downs Homestead, north of Rockhampton Downs Homestead, in the eastern part of Lake Sylvester, and between Rockhampton Downs and Brunette Downs Homesteads. These areas are also characterized by groundwater of low salinity.

Recharge to the South-eastern Basin appears to be from the north and from the west. A small area of recharge occurs around the headwaters of Western Creek in the east. A tri-lobate spur in the 575-foot contour near Avon Downs Homestead is reflected in the chemical characteristics of the groundwater and appears to outline an area of recharge. This spur separates two valleys in the piezometric surface: one centred on the Ranken River, the other between the James River and Happy Creek.

The recharge to the groundwater basins is obviously governed by the amount of rainwater that can penetrate to the aquifers either by direct percolation through the surface soils or is brought in from the margins by streams and subsurface flow. These factors are in turn controlled by the annual rainfall and the characteristics of the sediments above the aquifer. Table 4 indicates the surface area occupied by the various geological units in that part of the region relevant to the groundwater system i.e. it excludes most of the Gulf Fall drainage but includes the drainage areas of Carrara, Don, and Corporal Creeks, and the Gregory River, which all traverse Cambrian outcrops.

TABLE 4: AREAL DISTRIBUTION OF GEOLOGICAL UNITS

Unit	Area	Distribution
Alluvium (Cza)	1000 sq. miles	Internal drainage Lakes, some river valleys
Black soil (Czb)	17,000 sq. miles	Widespread over entire region
Sand & lateritic material (Czs & Czl)	12,000 " "	Large areas in west, north, and south of region: discrete areas in black soil country
Travertine (Czt)	750 " "	Southern part of region

Unit	Area	Distribution
Tertiary limestones (Ta, Tb, Tl)	1000 sq. miles	Mainly in Barkly Internal Drainage Basin; some about Alexandria Homestead and Georgina River Valley
Mesozoic sandstone siltstone and conglomerate (M, Kl)	250 " "	Northern and southern part of region
Cambrian carbonate sandstone & siltstone (Ꞓm, Ꞓmb, Ꞓmw, Ꞓmk, Ꞓmy, Ꞓd)	1500 " "	Small outcrop areas over entire region
Precambrian (mainly sandstone)	1500 " "	Between Puzzle and Buchanan Creeks on eastern margin, and north of Gallipoli Homestead

Noakes (1954) considers the more likely points for recharge are outcrops and lateritized outcrops on the margins of the basin, the upper portions of the stream channels where sand occurs over sediments, and low rises where lateritization occurred and where light-textured soils now remain. The total area of possible intake points is from Table 5 about 17,000 square miles, made up of 12,000 square miles of sandy and lateritic soils and 5000 square miles of outcrop. If we assume an average annual rainfall of 15 inches over the possible intake areas and assume because of unknown factors that only 50 percent of the area will act as intake, the amount of rain falling on probable recharge areas is $15x8500x14x10^6$ gallons i.e. $1785x10^9$ gallons per year. Turning now to the yield from the 360 working bores we find if they draw 2000 gallons an hour each for the entire year ($17x10^6$ gals) the total draught is $63x10^8$ gallons. Therefore to replace the amount of groundwater removed we require a run-in of about 0.35 percent of the precipitation over the recharge areas. This is a maximum figure because we have not considered intake areas outside the region, particularly to the south, probable intake in some of the black soil areas, and the fact that probable maximum annual withdrawal for the bores would average $5x10^6$ gallons per bore instead of the assumed $17x10^6$ gallons. Therefore the figure 0.35 percent is more than adequately compensated for any errors in the assumed average annual intake. Because of the lack of detailed knowledge about water movement, the ratio of withdrawal to precipitation is of academic interest only. But what is important is its very low value, and the subsequent implication that the groundwater reserves are very large, and could therefore cope with a much larger withdrawal without serious effect on the availability of groundwater over the region.

CHEMISTRY OF THE GROUNDWATER

CHEMICAL DETERMINATIONS

Two hundred and thirty samples of groundwater for chemical analysis were collected from selected bores during 1962: of these 38 were analysed by the Bureau's laboratory in Canberra, and the remaining 192 by the Australian Mineral Development Laboratories, Adelaide.

All reasonable precautions were taken during sampling. Bores operated by windpumps were sampled only during periods of moderate to strong winds; engine pumps were operated for at least 30 minutes before a sample was taken. Most of the working bores visited were operated by the stations at least once a week, but many had not been in operation for several weeks or longer. In the latter case the sample was taken only after clear water had been issuing from the outlet pipe for 30 minutes. Samples were collected in plastic bottles and air-freighted to the laboratories shortly after collection. In some instances there was a delay of some weeks between sampling and analysis and the values of pH obtained in the laboratory may bear little resemblance to the pH of the waters in the aquifers; consequently pH values have been ignored in this study. A sample was taken from the turkey nest + at Brunette Downs Bore K6 (R.N. 3105) and analysed by the Animal Industry Branch, Alice Springs in October 1960. Table 5 shows the comparison between this analysis and an analysis of water taken from the bore-head during the 1962 survey.

TABLE 5 : Analyses of Brunette Downs Bore K6 (in parts per million)

	Turkey Nest	Bore-head	Variation
Sodium	1248	937	33%
Potassium	54	50	8%
Calcium	289	215	35%
Magnesium	206	141	46%
Chloride	1820	1365	33%
Sulphate	1442	983	49%
Bicarbonate	285	297	-4%
Carbonate	Nil	Nil	
Fluoride	4.0	4.75	-18%
Total dissolved solids	5349	3900	27%
pH	7.8	7.35	

This comparison clearly indicates the effect of concentration by

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+ A raised, circular (but sometimes square) earth tank for storage of water from bores, formed by scooping the soil into a continuous wall, the top of which is above the original ground surface. The height provides automatic refilling of drinking troughs at or near ground level by means of float-valves.

evaporation; it also shows that this effect is not in a constant proportion for each of the components. This is probably caused by variations in solubility products of various constituents, by fixation of constituents by living matter in the water, by base exchange reactions with the clayey walls of the tank, by the length of time between successive periods of pumping bore water into the tank, and by the duration of the periods of pumping.

The variations show the futility of sampling the turkey nest to ascertain the geochemistry of water in the aquifers. Sampling the turkey nest may give a truer picture of the content of the water the stock are actually drinking at the time of sampling, but it obviously can vary. The chemistry of recently-pumped water from the bore is the best guide for comparison between bores provided it is realized that it indicates the minimum concentration of total solids the stock will receive. These variations also indicate the need for continual sampling throughout the year of surface waters (or groundwater stored at the surface) if these are used for extensive agriculture.

In addition to the sampling by the Bureau, some of the bore waters had previously been sampled by station staff and drillers, and forwarded for analysis to the Animal Industry Branch, Alice Springs. Several of the present (1962) station managers consider that some of these samples taken from established bores were either taken from the turkey nest, incorrectly labelled, or not taken carefully (e.g. unrinsed and contaminated containers); in the case of sampling on completion, errors can be introduced by incorrect labelling, contaminated containers or contamination by drilling fluids and aquifers in upper levels. Another source of error occurs when completion samples are labelled with the bore number as determined by the sequence of drilling, but the bore number is sometimes allocated by the sequence of equipping.

Because of these potential sources of error and the age of many of the A.I.B. analyses, many of the bores were re-sampled in 1962. Thirty-five A.I.B. analyses have been selected and are included in this study. In addition, another seven A.I.B. analyses have been included for comparison.

About half of the 1962 samples were analysed for 20 chemical parameters and the remainder for 10 chemical parameters. In addition the pH, total dissolved solids, and specific conductivity were determined for all samples, but these features are not always recorded on the A.I.B. analyses.

Total Dissolved Solids

The determinations of total dissolved solids (TDS) listed in appendix C have been determined by evaporation to dryness at 180°C.

The TDS is a basic indication of the salinity of a water sample and is used as the overall guide of water quality.+

The salinity tolerance for domestic use varies from area to area. Rainwater & Thatcher (1960) report that the U.S. Public Health Service recommends a maximum of 500 ppm but permits 1000 ppm. Keith Ward (1951) reviews various opinions on the salinity of domestic water supply and his discussion makes it clear that much depends on the tolerance of the individual and also on what the individual expects in the way of a water supply. He tabulates specifications for various water supplies determined by E.S. Simpson in Western Australia as follows:

Water for a large town	70 gr/gallon (1000 ppm)
" " " small town	105 gr/gallon (1500 ppm)
" " individual farms	210 gr/gallon (3000 ppm)

Jephcott (1956) gives the same figures, and considers 3000 ppm as a maximum limit if the consumer is used to saline water. In any case the potability of saline waters is generally determined by the concentration of one or more individual ions, and a perfectly palatable water may be rejected because of a high concentration of some harmful constituent.

Tolerances for stock vary, but most Australian workers agree within close limits; variations occur mainly through the type of feedavailable to the stock, season of the year, and climate. Keith Ward (op.cit.) gives the following figures as determined by Dr. R.L. Jack:

Horses in work	437 gr/gallon		(5350 ppm)
Horses at grass	547 gr/gallon		(7800 ppm)
Cattle	656 "	"	(9400 ppm)
Sheep on saltbush feed	875 "	"	(12400 ppm)
Sheep on grass feed	1094 "	"	(15600 ppm)

+ It should be noted, however, that the concentration of individual constituents must be taken into account in determining the suitability of water for specific purposes. This is discussed under those ions which cause trouble, e.g. sulphate, fluoride, and others.

As with water for human consumption, the usability of water for stock purposes, as determined by TDS, is still subject to acceptable concentrations of certain individual constituents. These are discussed later.

A discussion of agricultural requirements in relation to salinity is beyond the scope of this report. At present no agriculture is carried out in this region except for small vegetable plots on some stations. The plants grown are tolerant to the local water supplies, and this factor together with rotation of plots produce acceptable results.

The salinity of the bore-waters of the region in terms of the total dissolved solids is given in Appendix C. Isosalinity contours are given in Figure 11 and Plate 6. The concentration of total dissolved solids ranges from 31 ppm for Alexandria No. 47 (R.N. 3136) to 10,850 ppm for Brunette Downs Dlo (R.N. 2280).

The low value for Alexandria No. 47 appears to be anomalous, but most of the Alexandria bores have values of less than 500 ppm and these occur in the northern and central part of the Ranken 1:250,000 Sheet area. Other areas of low salinity (1000 ppm) occur in the southern part of the Alroy Sheet area between Frewena and Dalmore Downs Homestead, south-west of Anthony Lagoon Homestead, between Brunette Downs and Rockhampton Downs Homesteads, and in a linear discontinuous belt which trends north-north-westwards from Alexandria Homestead along the eastern margin of the Internal Drainage Basin. Areas of moderately high salinity occur north-east of Alroy Downs Homestead (6000 ppm), two areas south-west of Brunette Downs Homestead (7000 ppm), and an area north-east of Brunette Downs Homestead (Fig. 11). Areas of moderate salinity are outlined by the 4000 ppm contour, mainly in the western and central part of the region. Most of the water in the western part of the region is unpalatable to humans; an area of groundwater having a salinity higher than 300 ppm extends from near Anthony Lagoon eastwards to Creswell Downs Homesteads, southwards through Brunette Downs to north-east of Alroy Downs Homesteads; thence it swings westwards and in discontinuous areas extends to the west and north of Rockhampton Downs Homestead. This general trend is observed in the values of other constituents discussed later. The partial, but abrupt, westerly displacement of the contours east of Brunette Downs Homestead is also apparent in other sets of contours.

A study of the changes in the amount of total dissolved solids may provide information on the direction of groundwater flow and perhaps to a lesser extent on the nature of the aquifers. Schoeller (1959) considers that the total salinity is a function of both the transit of water through the aquifer (i.e. the time of contact) and the availability of soluble material in the aquifer. Consequently, water in or near the recharge areas can be expected to contain smaller amounts of dissolved matter than water which has progressed further through the aquifer or aquifer system. It can also be expected that water in areas of low hydrodynamic gradients will contain more dissolved matter than waters occurring elsewhere. Following on from these hypotheses, water in stagnant or semi-stagnant conditions will contain the highest amount of dissolved matter for waters in a particular region. Schoeller also notes modifying phenomena such as climate, saline content of the water reaching the squifer, pore space, and other factors.

If low TDS and increasing TDS indicate recharge areas and directions of groundwater flow respectively, then the isosalinity contours (Fig. 11) should reflect the piezometric surface (Fig. 9). This certainly does happen in a regional sense: a belt of low salinity values (1000 ppm) between Wonarah and Alexandria Homestead separates two areas of higher salinities - one to the west and one to the south-east. The area of low salinities corresponds to an area of high piezometric surface which strikes northwards from between Wonarah and Soudan Homestead, and with deviations passes to the east of Alexandria Homestead (Fig. 9).

The western area of higher salinities broadly corresponds to the groundwater basin centred on the Barkly Internal Drainage Basin as outlined by the piezometric surface. Within this Basin there is a relationship between salinity and the piezometric surface. On the north-eastern, eastern, and southern margins the decrease in elevation of the piezometric surface is accompanied by a marked rise in the content of total dissolved solids. This is particularly evident in the north-eastern part which is a probable recharge area or at least close to the recharge area. The belt of moderate to moderately high salinity values as outlined by the 3000 ppm contour closely approximates an area of low piezometric surface as outlined by the 550 foot contour. The 550 foot contour also outlines the saline areas to the west and north-west of Rockhampton Downs Homestead. The 530 foot contours outline in part the areas of highest salinity, suggesting stagnation or semi-stagnation of some of the groundwater. In the vicinity of Anthony Lagoon Homestead an increase in the salinity in a northerly direction is accompanied by a slope in the piezometric surface from above 550 feet to below 500 feet. An area of low salinity (1000 ppm) to the west and south-west of Anthony Lagoon Homestead is outlined by an area of high piezometric surface (575 feet above sea level). A probable recharge area outlined by the 575 foot contour, west of Brunette Downs Homestead, is well reflected by an area of low salinity outlined by the 1000 ppm and 500 ppm contours. The displacement of salinity contours and the consequent peninsula of low salinity values east of Brunette Downs Homestead is repeated, but to a lesser extent, in the elevation of the piezometric surface.

The south-eastern area of higher salinities corresponds to the groundwater system which appears to be co-extensive with the Georgina River Basin. Salinities increase in a south-easterly direction, and the height of the piezometric surface decreases. An area of low salinities (500 ppm) in the northern part of the Ranken Sheet area corresponds to an area of high piezometric surface (600 feet above sea-level), and suggests a recharge area. Two lobes in the 1000 ppm contour near Avon Downs Homestead are reflected, though attenuated, by lobes in the 550 foot contour of the piezometric surface.

Consequently, it is apparent that there is a relationship between the total dissolved solids in the water and the position of the water in the hydrodynamic system as indicated by the standing water levels. This relationship is further amplified in the discussion on the chemistry of the waters.

Specific Conductivity

The values for specific conductivity listed in Appendix C have been determined at 25°C. The conductivity of a water solution is a function of the dissolved matter in the solution and is largely controlled by ionic dissociation and the concentration of the solution. For simple solutions there is a simple relationship between concentration and conductance, the graph of which is linear for low concentrations; but for increasing concentrations the slope of the graph will alter by an amount and direction which varies for different salts. In addition, the linear relationship is different for various salts (Hem, 1959). Consequently, no simple exact relationship can be expected between specific conductivity and total dissolved solids in such heterogeneous solutions as may be found in bore-waters. Waters which contain one very dominant anion and one very dominant cation may tend to give a simple relationship, but such waters are rare. A qualitative relationship does exist between these factors - the higher the total dissolved solids, the higher the specific conductance. Hem (op. cit.) gives the following relationship:

(Specific Conductance in $/^{u}$ mhos at 25°C) X A = Total dissolved solids in ppm.

where A varies between 0.5 and 1.0, and usually lies between 0.55 and 0.75.

The value of the factor A lies between 0.5 and 0.945 for the groundwaters examined in this region; but of these values only 16 percent lie outside the range 0.55 to 0.75 - half of these below 0.55 and half above 0.75. Figure 12 shows the frequency distribution of factor A for the nine chemical types of water discussed in a later section. The effect of the major anions on this factor is immediatly apparent. Low values have been plotted on the left of the diagram and high values on the right. Dominantly chloride type waters are ranged about the centre of the diagram between values 0.555 and 0.785. The dominantly sulphate waters range over the right hand side of the diagram between the values 0.745 to 0.945, and the dominantly bicarbonate waters lie to the left between 0.51 and 0.74, but mainly (85 percent) between 0.51 and 0.645. The chloride waters in which sulphate is the dominant secondary anion (sulphato-chloride) show a slight but definite shift to the right, and those in which bicarbonate is the secondary anion tend to move to the left. These variations are more marked with the sulphate type waters; they are present but less well-defined in the bicarbonate waters.

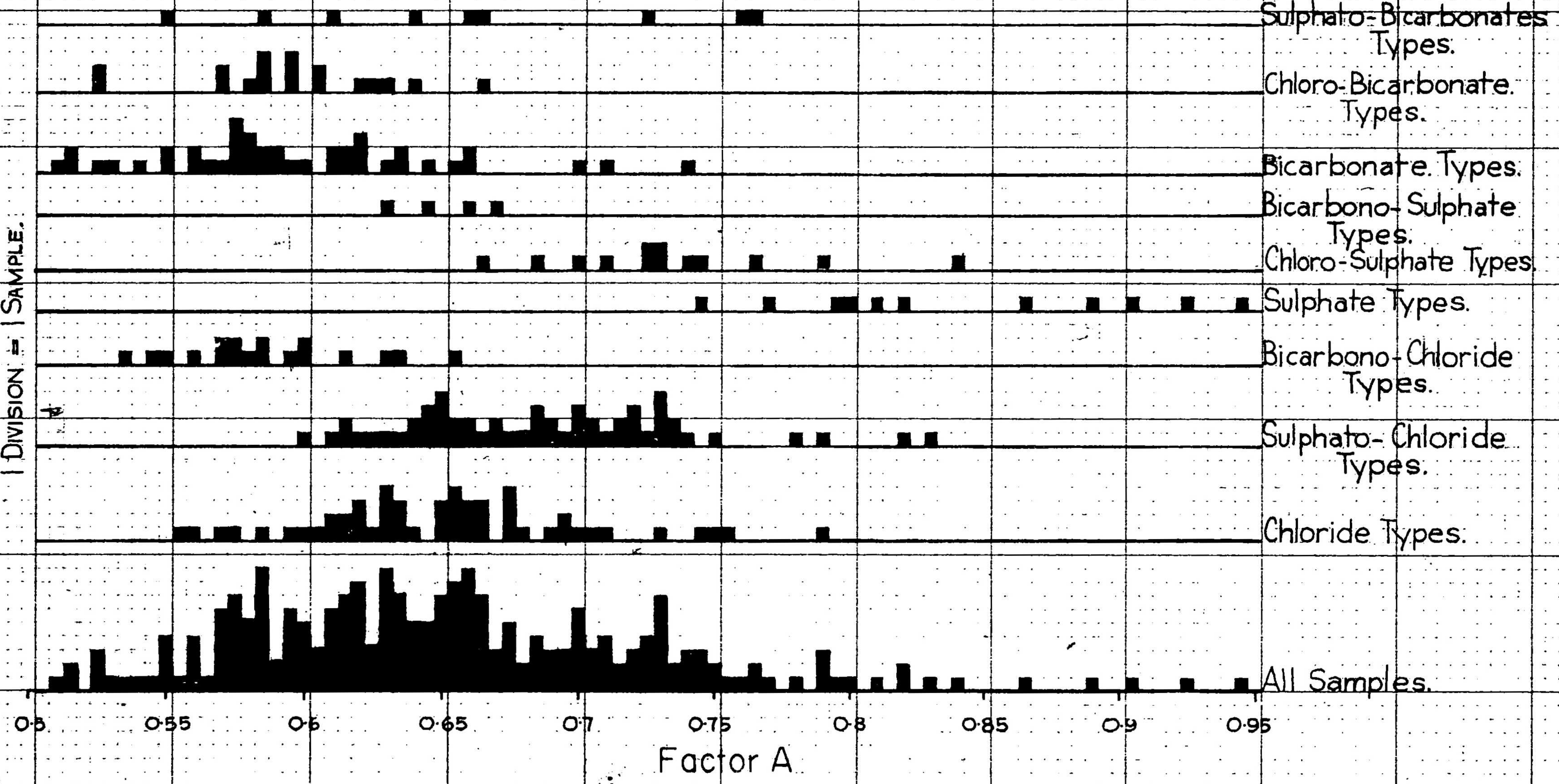
The variation of this factor is further modified by the cationic content of the solution, which probably explains in part the wide range in values. However, no evaluation of cation influence has been attempted.

Because of the wide ranges of the factor A and the consequent lack of an exact relationship between TDS and specific conductivity, the latter parameter has a restricted use in a geochemical investigation of groundwater. But since both the TDS and the specific conductivity can be rapidly and easily measured in the field by portable equipment these parameters can be used as a

Figure 12

RELATIONSHIP BETWEEN CHEMICAL TYPE AND THE RATIO OF T.D.S. TO SPECIFIC CONDUCTIVITY

FACTOR A = T.D.S. IN P.P.M./SPECIFIC CONDUCTIVITY IN MICROMHOS/CM.



Bureau of Mineral Resources, Geology and Geophysics *To accompany Record 1966/11* NT/A/107 guide to sampling whilst the investigator is still in the field.

If a new bore is tested in an area previously regarded as containing waters of a particular anionic type and factor A is found to depart from the range expected, it would be as well for a sample to be taken for a full laboratory analysis. Factor A may prove to be a valuable tool if the shallower supplies on the Tableland are ever utilised, inasmuch as it may serve as a warning of the intrusion of a different water-type into the aquifer from deeper aquifers, and thereby indicate the need for a complete analysis and a careful watch on the withdrawal from the bore.

Specific conductivity on its own may be used as a quick field check on bores which have been previously sampled. A variation of 10 percent or more in the value indicates a substantial change in salinity which should be checked immediately by a field salinometer. An increase of groundwater salinity is more likely to be caused by the influx of water of a different chemical type from another aquifer. It would be as well therefore to forward waters showing such a variation to a laboratory for a complete analysis. When comparing field values of specific conductivity with those tabulated in a laboratory determination a temperature correction must be applied: conductivity increases by 2 percent for every 1°C rise in temperature.

Sodium and Potassium

For all samples analysed by the B.M.R. and A.M.D.L., sodium and potassium values have been determined by flame-photometry; they are not computed values. The method used by the A.I.B. is not known, but because of some imbalance between anionic and cationic values in epm+ the alkali content is probably given as determined rather than computed values. For some of the earlier A.I.B. analyses no values for sodium and potassium were given; computed equivalents for combined sodium and potassium were obtained to enable these samples to be classified: these analyses are so marked in Appendix D.

Rainwater & Thatcher (1960) state 'sodium is not particularly significant in drinking and culinary water except for those persons having an abnormal sodium metabolism'. The same authors report 1000 - 2000 ppm of potassium as the limit in drinking water according to E.W. Moore. It is highly probable that a water would be condemned because of the concentration of some other component long before it was rejected because of high soda or

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+ equivalents per million.

potash contents.

Sodium can have a very harmful effect on soils if waters containing high concentrations of it are used for irrigation. Sodium in the water may be exchanged by calcium and magnesium from the soil thereby producing a soil high in sodium content and deficient in the other two. The effect produces an alkaline soil with tilth and permeability seriously affected. The exchange is lessened with increasing calcium and magnesium content of the water; this feature provides an index for likely troubles, and the sodium absorption ratio (S.A.R.), used by soil scientists, is defined as follows:

$$S.A.R. = \frac{Na^{+}}{\sqrt{\dfrac{Ca^{++} + Mg^{++}}{2}}}$$

, where concentrations are expressed in equivalents per million. In determining the sodium hazard, this index is further modified, as illustrated in Hem (1959), by the salinity as indicated by the specific conductance. A water having a specific conductance of 100 $/^{u}$ mho has a high sodium (alkali) hazard if the S.A.R. lies between 18 and 26, but if the specific conductance is 5000 $/^{u}$ mhos the same sodium hazard applies for a much lower S.A.R. range - about 7 to 11. Further discussion on these effects is given in some detail together with references by Hem (op. cit.).

Since there is no planned or present irrigation on the Tableland, the S.A.R. values have not been calculated. The chloride waters around Brunette Downs are very high in sodium relative to calcium and magnesium and would have both a high salinity and a high sodium hazard. If agriculture is undertaken even on a small scale in future years, it may prove worthwhile to utilise the shallower aquifers which at present are believed to contain fresher water than the deeper ones.

The sodium content ranges from 11.9 ppm in Alexandria No. 39 (R.N.3129) to 2790 ppm in Brunette Downs D10 (R.N. 2280[+]). Alexandria No. 47 has 6.1 ppm sodium but the sample, which contains only 31 ppm of TDS, is anomalous. Sodium is the dominant cation in the groundwaters of the Barkly Tableland (Fig. 13b): it is the dominant cation in all but fourteen of the thirty-one chemical classes of waters, and in eight of these fourteen the difference between the sodium concentration and that of the major cation is less than

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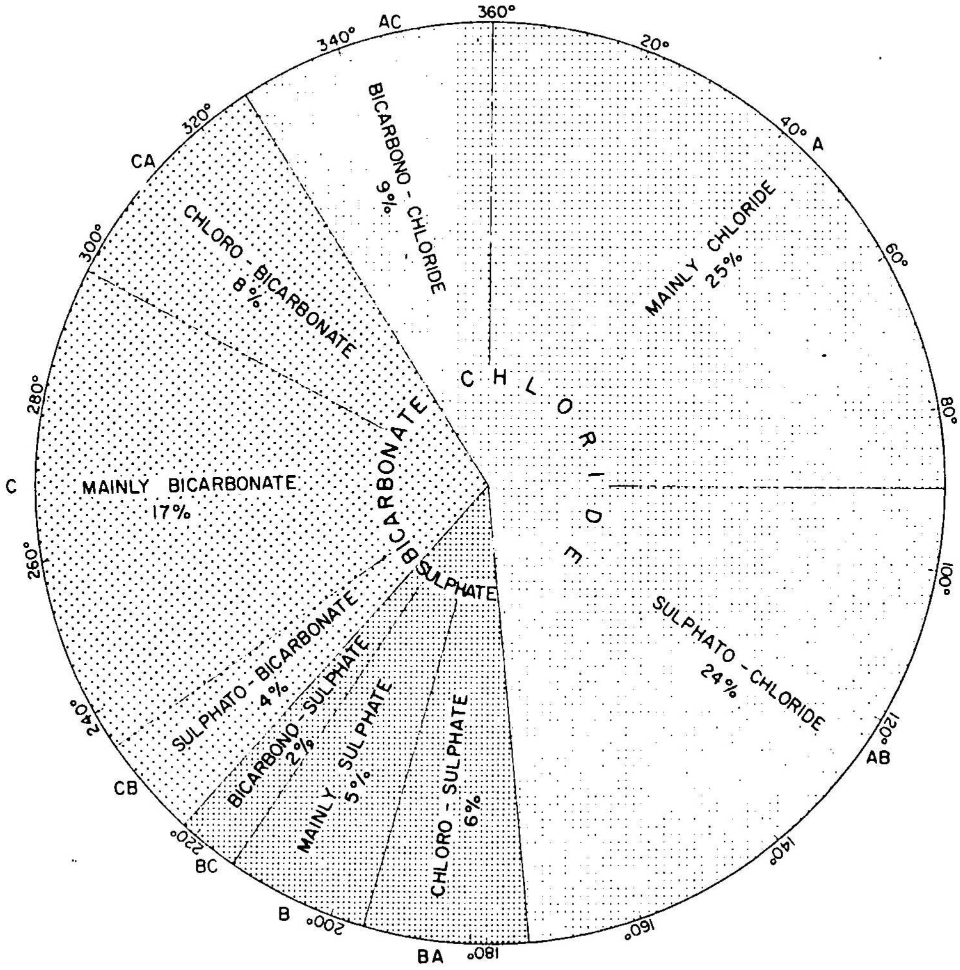
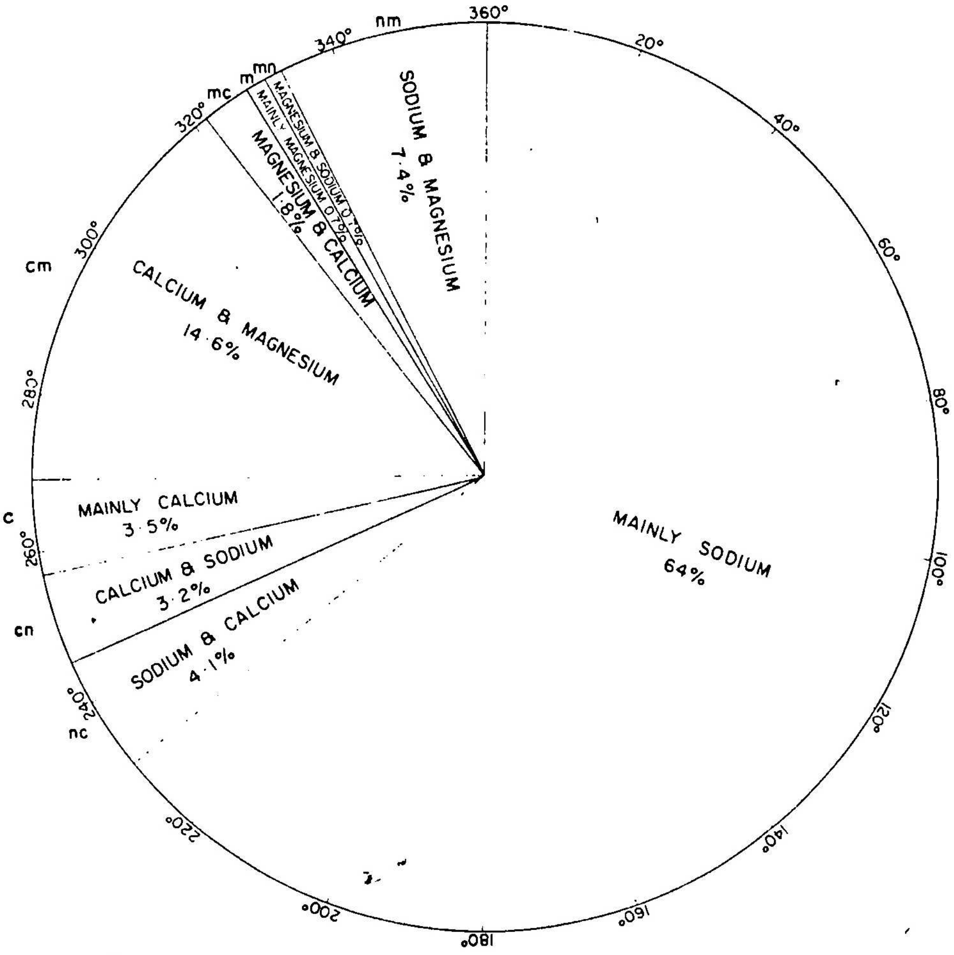
[+] This bore, though equipped in 1960, has been abandoned because of the high salinity.

PERCENTAGE DISTRIBUTION OF CHEMICAL TYPES OF BORE-WATER IN THE BARKLY TABLELAND

a) Main classification—based on anions



b) Minor classification—based on cations



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10 percent of the total cationic concentration.. The highest potassium concentration is 160 ppm in Brunette Downs No. D44 (R.N. 3655). The potassium content generally varies directly with the sodium content, and in classifying the water types the potassium and sodium equivalents have been combined.

Hem (1959) considers that waters associated with carbonates are normally low in sodium unless there is contamination from beds of evaporites associated with the carbonates. If the sodium is coming from sources in the carbonates it obviously cannot exceed the level of its concentration within the rocks since the calcium and magnesium must be dissolved first to release the contained sodium; if however the calcium and, less probably, the magnesium, are removed by precipitation the sodium content will rise. In this situation, once the solubility product of at least calcium with the anions in solution has been exceeded no further dissolution in the case of limestone and very little dissolution in the case of dolomite can occur, with the subsequent retardation of sodium release. It appears therefore that a process of precipitation is not the complete answer. If however, there are significant amounts of shales, silty sandstones, or silty carbonates interbedded with the carbonates, sodium may be rapidly dissolved from these because of its high solubility. In addition, if these rocks contain sodic clays an extra gain in sodium and loss in magnesium and calcium may occur through base exchange. It is interesting that the drillers' logs of bores in the Internal Drainage Basin do indicate a greater content of non-carbonate rocks in the sequence than is apparent from outcrop mapping.

Calcium

All water samples have been analysed for calcium. In those samples for which strontium was not independently determined it is included in the figure for calcium as an equivalent amount of calcium.

Calcium is not significant in determining the potability of water for humans or stock if it is present as sulphate or bicarbonate; however if present as chloride it is harmful to stock, but not many waters have an excess of calcium over its equivalent of sulphate plus carbonate. Calcium gives little or no taste to water, consequently even high values do not seriously detract from its palatability.

Calcium is important in agriculture: it lowers the Sodium Absorption Ratio of waters and soil and hence tends to counteract the effects of sodium in base exchange reactions. This has been discussed under sodium. Calcium, together with magnesium causes hardness in water: temporary hardness is caused by the bicarbonate of these cations, and permanent hardness by their combinations with sulphate and chloride. This feature is important in industry; it has no direct significance in the Barkly Tableland.

Calcium is an important constituent of the bore-waters of the Barkly Tableland (Fig. 13b) and has been used in the sub-classification of the water groups. It is the dominant ion in eight of the thirty one classes, but is subordinate to both sodium and magnesium in seven of them. It is dominant in three bicarbonate types, in three sulphate types, and in two chloride types. Hem (1959) considers that high calcium associated with high sulphate may indicate gypsiferous deposits in the aquifer; he also suggests that low values of calcium may indicate base exchange between water and aquifer.

The calcium content of the waters ranges from 2.9 ppm in Alexandria No. 47 (R.N. 3136) and 31 ppm in Brunette Downs D39 (R.N. 2580) to 634 ppm in Rockhampton Downs No. 22 (R.N. 2229). The relationship between calcium and magnesium and its indication of dolomite and dolomitic rocks is discussed under the ionic ratios (P 63).

Magnesium

The determination of magnesium is important in water intended for consumption by humans and stock because of the cathartic and diuretic properties of this element. A high concentration of magnesium can cause scouring in cattle, and Jephcott (1956) recommends the following limits for stock: 300 ppm for horses, 400 ppm for cattle and 500 ppm for sheep; he lists domestic limits at 125 ppm for cities, and 200 ppm for both small towns and stations. The U.S. Public Health Service (quoted in Rainwater & Thatcher, 1960) recommend 125 ppm.

Magnesium is beneficial in waters used for agriculture: it flocculates the soil colloids and maintains good soil structure and permeability; it complements calcium in reducing the sodium hazard of irrigation waters. Together with calcium it is responsible for the hardness of water.

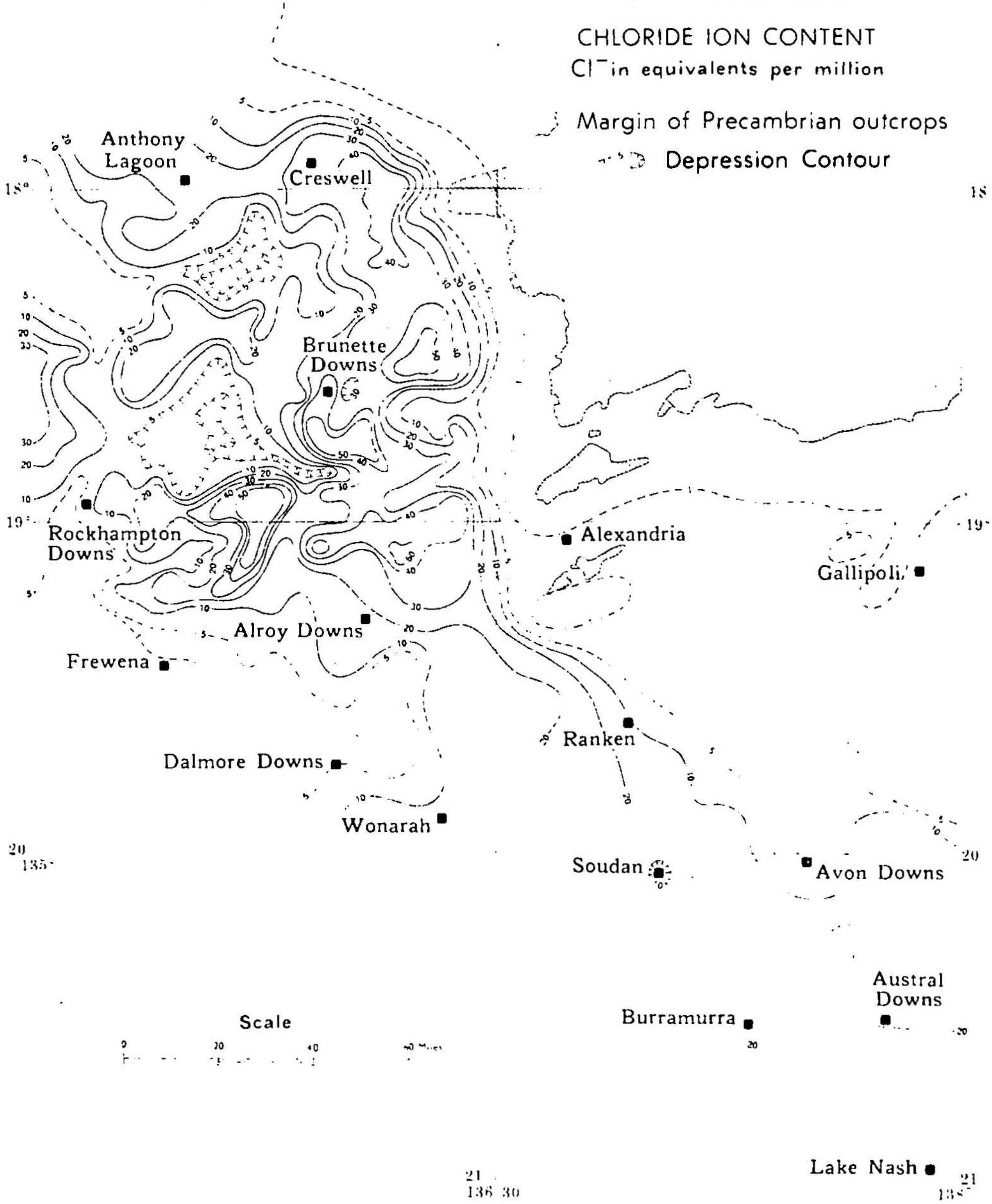
The bore-waters of the Barkly Tableland have a magnesium content ranging from 2.3 ppm for Alexandria No. 47 (R.N. 3136) and 21.7 ppm for Anthony Lagoon No. 18 (R.N. 2161) to 424 ppm Brunette Downs D 20 (R.N.2288).

Figure 14

WATER BORES STUDY
BARKLY TABLELAND

CHLORIDE ION CONTENT

Cl⁻ in equivalents per million



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It is apparent that the magnesium content, though it may cause some discomfort to humans, presents no serious stock problems.

The relationship between magnesium and calcium in waters from the carbonate rocks is discussed in the section on ionic ratios.

Chloride

The chloride ion is the most dominant of the anions in the bore-waters of the Barkly Tableland (Fig. 13a). It is the major anion in eight of the classes, secondary to sulphate in six of the classes, secondary to carbonate in ten, and is the minor anion in only seven of the classes.

Chloride is the ion mainly responsible for the unpleasant taste of many of the bore-waters in the central and western part of the region, and renders many of them unsuitable for continuous use by humans. Some of these bore-waters are in any case unfit for human consumption because of a high sulphate, magnesium, or fluoride content. Chloride ion imparts a distinct salty taste to water, but the threshold of detection varies with the individual. Rainwater & Thatcher (1960) report 250 ppm as the limit for water for domestic use; Jephcott (1956) gives the same figure for city water supplies, and in addition gives 375 ppm and 750 ppm as the upper limit for town and station supplies respectively. Magnesium chloride can be dangerous in boilers or hot water systems because on heating it produces hydrochloric acid; excessive chloride in water can corrode and tarnish fittings. Chloride can be harmful to stock if present as calcium or magnesium salts; referring to sodium chloride, Jephcott (1956) writes 'if the content does not pass 75 percent of the total maximum tolerance of soluble salts stock suffer no injury'. Chloride ion can be injurious to some crops, and in this respect it is considered to be twice as toxic as sulphate.

In the bore-waters of the Barkly Tableland the chloride concentration ranges from 7.1 ppm in Alexandria No. 47 (R.N. 3136) and 13.4 ppm in Alexandria No. 39 (R.N. 3129) to 3860 ppm in Brunette Downs No. D20 (R.N.2288). Chloride ion distribution in equivalents per million is shown in Figure 14 and Plate 7. A strong similarity between the contours on the chloride concentration and the isosalinity contours emphasizes the major role played by the chloride ion in the total salinity of the bore-waters. The high values (greater than 30 epm, i.e. 1065 ppm) extend in a sigmoidal belt from about Creswell Downs Homestead southwards through Brunette Downs Homestead to north and north-east of Alroy Downs Homestead; thence the belt swings westward to north of Frewena, and occurs also as an isolated area north-west of Rockhampton Downs Homestead. These areas of high chloride content correspond approximately to the areas of high TDS. The highest chloride values (50 epm) broadly correspond to the very high TDS values (6000 ppm).

The probable direction of groundwater flow as suggested by the piezometric surface and the isosalinity contours is reflected by the contours of the chloride ion content. The separation of the region into two basins is not immediately apparent, but is evidenced by a marked constriction in the 15 epm contours south-west of Alexandria Homestead. The probable areas of recharge in the north-east, east, south, and north-west are outlined by the 1 and 5 epm contours, as is the probable recharge area west of Brunette Downs Homestead. The peninsula of low salinity values east of Brunette Downs Homestead (Fig. 11) is reflected by a similar trend in the chloride values. In the eastern part of the area, both the chloride content and the total salinity increases in a southerly direction.

The origin of the chloride in the groundwater is speculative. There is a great deal of discussion in the geochemical literature on the anomaly of the abundance of chloride in natural waters, including the ocean, in contrast to the low chloride contents of most rocks; this discussion is adequately summarized in Hem (1959) and will be here referred to only briefly.

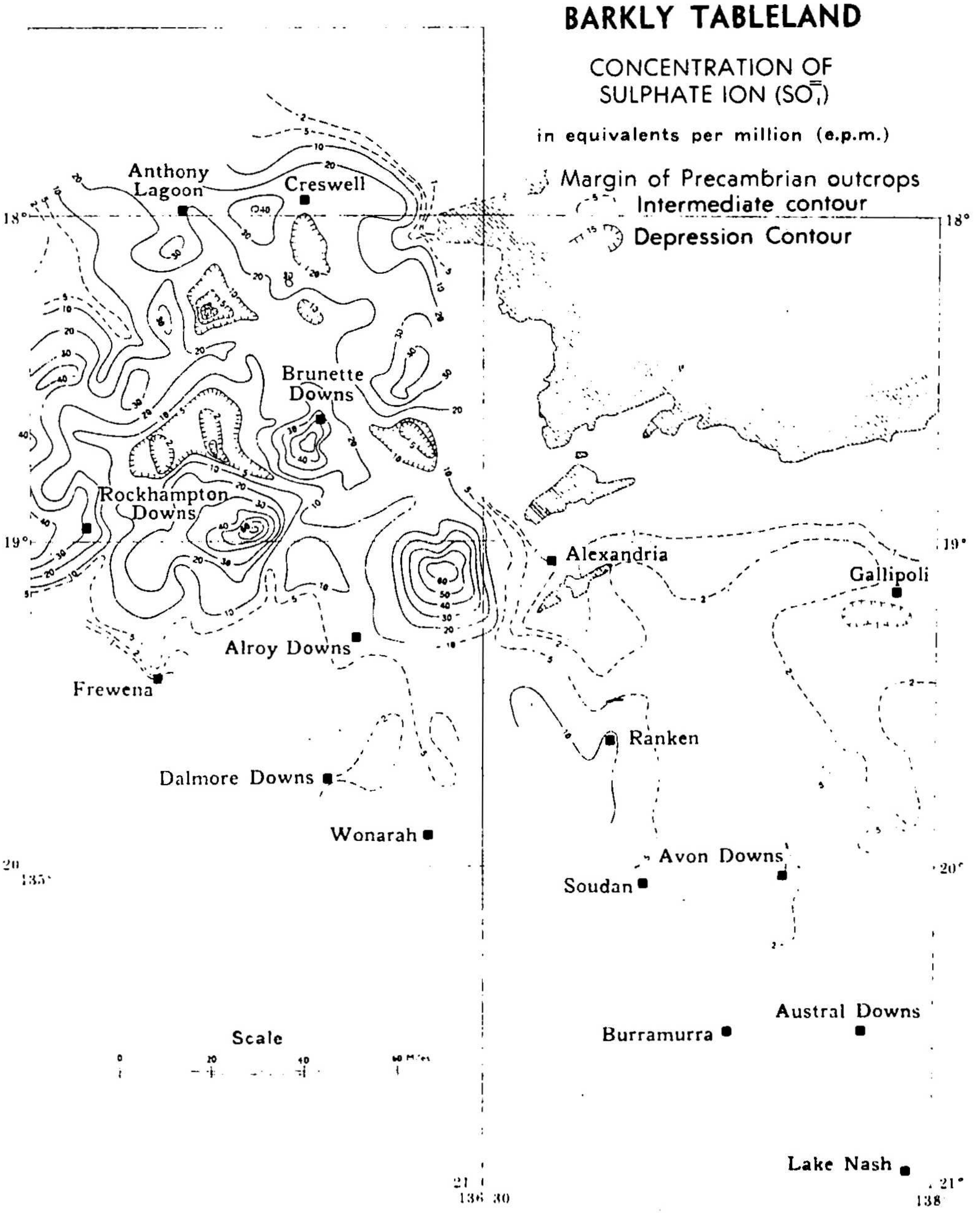
The occurrence of chloride in rainwater has been established, but knowledge of the concentrations in areas away from the coasts or major sources of pollution (industrial cities etc.) is sketchy. The term cyclic salt has been used for minute salt particles from ocean spray taken up into the atmosphere and returned to the ground - and in part the sea - by subsequent showers of rain. Hem (1959) describes some of the investigations on cyclic salt and has shown that the concentrations of salt in rainwater decrease progressively inland. The rainfall on the Barkly Tableland originates off the coast with the north-west monsoon, but the coast is at least 150 miles from the northern part of the Tableland and in a direction at right angles to that of the monsoon. It is therefore difficult to relate chloride concentrations of the groundwater to original chloride concentrations of the rain showers. Even though some concentration by evaporation may occur it does not explain the apparent rapidity with which the waters pick up chloride ions in their transit through the aquifers. Neither is it likely that concentration by evaporation would produce the high levels encountered in the bore-waters

Figure 15

WATER BORES STUDY
BARKLY TABLELAND

CONCENTRATION OF
SULPHATE ION ($SO_4^{=}$)

in equivalents per million (e.p.m.)



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because the chloride concentrations of two samples of surface-waters taken towards the end of the dry season were only 1 and 15 ppm (see page 18).

Because of the dominance of chloride in sea water, marine sediments may contain large amounts of chloride ion, either as salts in connate water or adhering to mineral particles; chloride ion is also common in evaporites. There is no doubt of the marine origin of the Cambrian rocks on the Barkly Tableland; however it is improbable that the groundwater is connate. The most likely origin of the chloride is from the solution of chloride salts contained in the rocks and occurring in probable interbeds of evaporites. Evaporitic conditions have been postulated for some of the dolomitic rocks in the region (Randal & Nichols, 1963), and the occurrence of gypsum, which is often associated with evaporites, is known in the sequence. Another probable source of chloride is the flooding of at least parts of the region in the north by a Mesozoic marine transgression, and the occurrence in other parts of the region of extensive brackish-water lakes (Skwarko, 1965). Even though the vertical transmissibility of the sea-bed or lake floor may have been very low, the duration and area of the sea and lakes could permit large volumes of water to intrude into the Cambrian rocks. Subsequent leaching of the ground surface after the drying-up of the sea and lakes would carry some dissolved matter into the groundwater system. The disposition of intake areas and the direction of groundwater flow during the Mesozoic may have differed from existing conditions; it is therefore impossible to evaluate likely points of intrusion and relate them to the changing salinities in the present groundwater system. Further discussion on the chloride content is given in the sections on chemical types and ionic ratios.

Sulphate

The determination of sulphate in bore-waters is necessary because of its cathartic effect on humans; sulphate has some effect on cattle, but in part it offsets the toxicity of selenium. The U.S. Public Health Service recommends an upper limit of 250 ppm of sulphate in water intended for domestic use (Rainwater & Thatcher, 1960); Jephcott (1956) gives the same figure for city water supplies and in addition gives 375 ppm for small towns, and 500 ppm for stations.

Sulphate in groundwater can be derived from gypsum and anhydrite, which are abundant in evaporitic sediments, and from the oxidation of sulphides in shales. Sulphate may be present in the evaporitic sediments as salts of sodium, potassium, and magnesium, and is readily available for solution. In semi-arid areas surface waters may be heavily charged with salts because of the incomplete leaching of the soils by the sparse rainfall and the consequent accumulation of soluble weathering products in the soil. Most salts are affected by low run-off, but Hem (1959) states that sulphate is the ion most affected. In this connexion it is noteworthy that gypsum crystals are widespread in the black soils in many parts of the Barkly Tableland; also the analysis of water from Long Waterhole shows a very high sulphate content. It is apparent that some of the waters may have initially contained considerable amounts of sulphate before their entry into the groundwater system, but the high values encountered in the central parts of the basin suggest that most of the sulphate content has been acquired during transit through the aquifers. Some of the drillers' logs have recorded gypsum at or near the main supplies, and pyrite is known in some of the shales and carbonate rocks. Evaporitic conditions have been postulated for some of the Cambrian rocks in this region (Randal & Nichols, 1963).

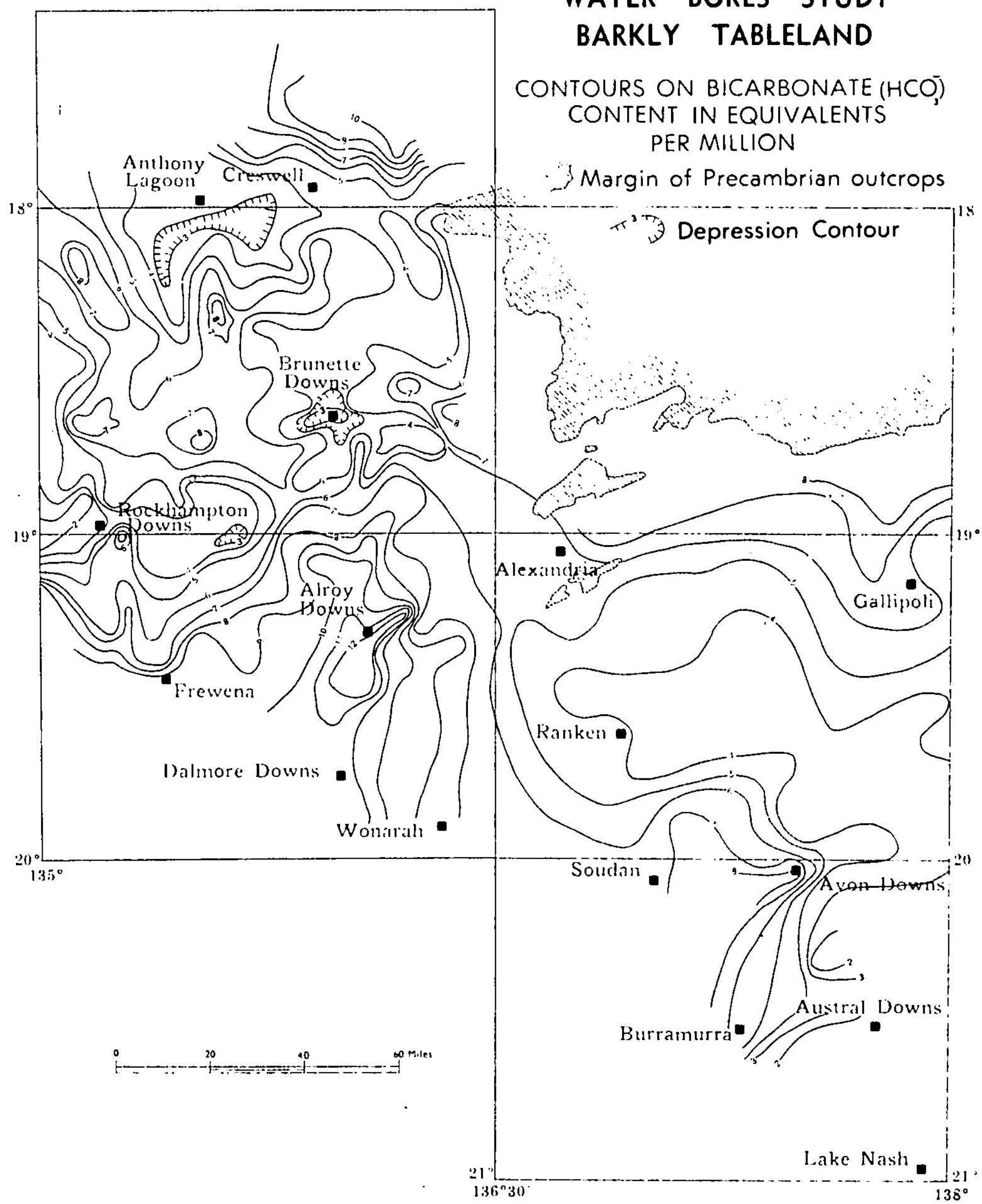
The sulphate content of the bore-waters ranges from 1.6 ppm in Alexandria No. 47 (R.N. 3136) and 13.6 ppm in Creswell Downs No. 14 (R.N.2746) to 3485 ppm in Brunette Downs No. D10 (R.N. 2280). Contours on the sulphate content in equivalents per million are shown in Plate 8 and Figure 15. The values in parts per million for city, small town, and station water supplies quoted above correspond to 5, 7.5, and 10 epm respectively. Most A.I.B. analysis forms on which the sulphate content is listed as above 250 ppm (about 5 epm) carry the remark that the water is not suitable for human consumption, but even if Jephcott's (1956) more liberal figure of 500 ppm (about 10 epm) for station supplies is accepted, it is readily apparent from Figure 15 that many of the bores are producing water which is unsuitable for continuous human consumption. The areas mainly affected are most of the Brunette Downs Sheet area, the southern part of the Wallhallow Sheet area, the northern part of the Alroy Sheet area, and a small area west of Ranken Store in the Ranken Sheet area. Some of the bores in these high sulphate areas, nonetheless, have been providing drinking water for homesteads for many years.

The contours of the sulphate content reflect features already noted in the sets of contours previously discussed. A saddle in the 5 epm contour between Alexandria Homestead and Wonarah tends to divide the region into two

Figure 16

WATER BORES STUDY BARKLY TABLELAND

CONTOURS ON BICARBONATE (HCO_3^-) CONTENT IN EQUIVALENTS PER MILLION



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separate basins; however lack of information in the south-eastern part of the region prevents a detailed assessment of the trends between Wonarah and Ranken Store. Nevertheless it is apparent that low values in the northern part of the Ranken Sheet area give way to higher values in the south. Areas of recharge and directions of groundwater flow, as postulated from increasing sulphate content, conform to the patterns previously established from contours on other parameters, and once more the high values are disrupted by a peninsula of low values east of Brunette Downs Homestead.

Further discussion on the sulphate ion is given in the sections on the chemical types of water and the ionic ratios.

Bicarbonate

All the bore-waters in this study were analysed for both bicarbonate and carbonate, but carbonate was detected in only one sample. A sample from Rockhampton Downs No. 11 (R.N. 394) was analysed by the A.I.B. in 1956 and contained 35 ppm of carbonate and 229 ppm of bicarbonate, but its pH was not recorded; normally carbonate ion is not present in waters below pH 8.2.

The bicarbonate is determined by an alkalinity titration and the result may therefore include an equivalent amount of the alkalinity contributed by constituents which hydrolize, mainly silicates, phosphates, borates, and ferrous chloride. However, the relative amounts of silica, phosphorous, boron, and iron to the total alkalinity figure are very small in these bore-waters, and A.D. Haldane (BMR, pers. comm.) considers that the reported bicarbonate figure gives a valid comparison between the bicarbonate contents of the bore-water samples.

The bicarbonate ion is not physiologically important to man or stock, but magnesium and calcium bicarbonate contribute to the temporary hardness of the water and may inhibit lathering of soap and may cause deposits in hot-water systems and boilers. This latter effect is apparent in some of the old steam engines used for driving the bore-pumps, which may still be seen near the bores.

The bicarbonate content ranges from 21.4 ppm in Alexandria No. 4 (R.N. 3136) and 98 ppm in Avon Downs No. 14 (R.N. 331) to 658 ppm in Dalmore Downs No. 9, put down originally as Barkly Highway No. 14A (R.N. 29). Carbonate minerals are widespread and because of the availability of atmospheric carbon dioxide, carbonate and bicarbonate ions are expected in most surface and groundwaters, but Hem (1959) states that waters of limestone terrains do not commonly exceed about 500 ppm (i.e. about 8 epm.). The bicarbonate contents for the waters under discussion have been contoured (Fig. 16 and Pl. 9) and with the exception of a large area on the Alroy 1:250,000 Sheet area most values are below 8 epm. High values occur in other areas west of Brunette Downs, south-west and south of Anthony Lagoon Homestead, and north of Creswell Downs.

Parallelism between the bicarbonate contours and other sets of contours is not immediately apparent, and in some areas the bicarbonate contours present a very confused pattern. A constriction in the 6 epm contours west of Alexandria Homestead tends to divide the region into two areas, but the high values to the south-west of this constriction are not fully repeated to the north-east consequently the effect is masked. In addition numerous lobes on the 5 epm contour in the Brunette Downs Sheet area mask the general trends of the contours.

The absolute bicarbonate levels generally decrease in the probable direction of groundwater flow which is also the established direction of increasing total salinity. This direction is also the direction of increasing sulphate content, and presumably during the transit of the groundwater through the aquifer, carbonate or bicarbonate is being replaced by sulphate. Values of 4 epm or less generally correspond to the most saline areas indicated by the isosalinity and chloride content contours. However in the eastern part of the region the development of the 4 epm contour is anomalous and at present inexplicable.

The bicarbonate content has been used as a major characteristic for division of the bore-waters into various types and is further discussed in the appropriate section. It is also further discussed in the section on ionic ratios.

Fluoride

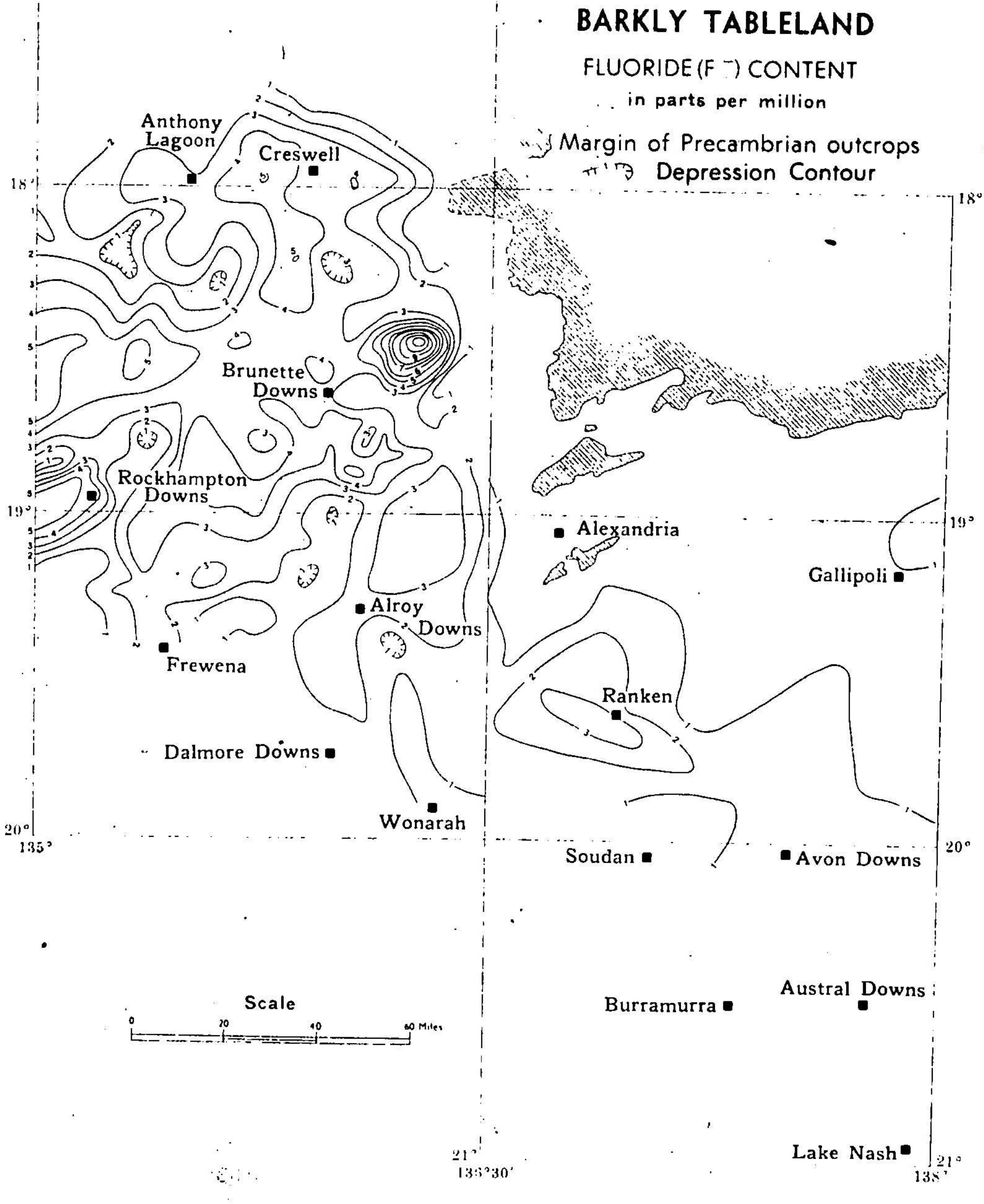
The fluoride content of waters, especially those waters intended for domestic consumption, has been of considerable interest and controversy in recent years. It has become increasingly difficult to separate fact from opinion in the literature in respect of fluoridation of water supplies as a prophylactic for dental caries in children. However, it is generally agreed that excess fluorine can be harmful to humans and to animals, but again the

Figure 17

WATER BORES STUDY BARKLY TABLELAND

FLUORIDE (F⁻) CONTENT

in parts per million



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concentration which can be safely ingested is not clearly defined. Many factors may be involved in fluoride metabolism and the variation in reported results may be due to unappreciated or indeterminable environmental factors. In dealing with this problem in the Barkly Tableland it would therefore be best to refer to the concentrations quoted by Jephcott (1956) who, whilst in Alice Springs, has analysed many waters of the Northern Territory, and who was therefore in a position to see and hear first-hand the results of various fluoride concentrations in this area.

Jephcott (1956) states: 'Fluorides are a source of controversy but broad limits can be suggested. The best values are about 1 ppm, although in an arid climate, like Central Australia, a limit of 0.8 ppm is sometimes set. If people are willing to accept the pitting or mottling of teeth, the limit can be raised to 2 ppm.' With respect to stock he says 'The upper safe limit is considered to be 6 ppm with a safe breeding level of 4 ppm. This is an arbitrary figure as stock are known to live at a level of 15 ppm without ill effects. The diet may influence the issue by converting the fluorine into non-utilizable forms, as in the case with aluminium salts'. The South Australian Department of Mines reports that cattle ingest 5 to 10 ppm of fluoride in the Maree-Birdsville area without apparent ill-effects, but that sheep have been seriously affected by the fluorine content of water (Dep. Min., 1959). Fluoride in the quantities normally encountered is not toxic to plants.

The fluoride content ranges from 0.05 ppm in Alexandria No. 47 (R.N. 3136) to 12.1 ppm in Brunette Downs No. 49 (R.N. 1229). Low values of 0.1 ppm occur in Creswell Downs No. 14 (R.N. 2746), Alexandria No. 4 (R.N. 738), and Alexandria No. 12 (R.N. 747).

Figure 17 and Plate 10 show contours of the fluoride content in parts per million: two areas are outlined by the 1 ppm contours between Alexandria Homestead and Wonarah, and these areas broadly correspond to the divisions previously noted in other sets of contours. There is a relationship between increasing fluoride content and the direction of groundwater flow and increasing salinity. There is sufficient diversity between the fluoride contours and the others to suggest that the fluoride content of the waters varies in part because of changing fluoride content of the aquifers, but analyses of aquifer rocks will be required to confirm this.

Even if the more liberal figure of 2 ppm of fluoride in domestic water is accepted, most of the bore-waters in the western part of the region would be regarded as unsuitable for human consumption, as also would those in a small area about Ranken store. Many of the homesteads in the region use water containing fluoride above the recommended limit.

Silica

Silica is not physiologically significant to humans or stock, but is frequently determined in water analyses. Silica content of waters used for irrigation is unimportant, but waters used in industry, especially in boilers, should be low in silica.

Silica in groundwater may be obtained from the weathering or reconstitution of silicate minerals, particularly feldspars; it may also occur through the solution of cryptocrystalline forms of silica such as chert and chalcedony. This latter origin is probably the one mainly responsible for the silica content of the bore-waters on the Barkly Tableland. Chert bands and nodules occur in most of the Cambrian carbonate rocks, especially the Camooweal Dolomite, and are abundant in the Tertiary carbonate rocks. Many of the carbonate rocks are silificied and the porosity of many of these is evidence of their attack by solutions. Re-deposited silica occurs as tiny quartz crystals in vughs in some of the carbonate and silicified carbonate rocks. Cambrian rocks at or near the laterite profile are extensively silicified.

Silica has been determined in all samples analysed by A.M.D.L. and B.M.R. Values range from 10 ppm in nine bores to 65 ppm in Brunette Downs D5 (R.N. 1993) and 64.5 in Dalmore Downs No. 8+ (R.N. 353). Contours of the values in parts per million are given in Figure 18 and Plate 11: west of Alexandria Homestead a saddle in contours divides the region into two areas as in the previous sets of contours. An interesting feature is the general decrease in silica content in the directions of increasing salinity.

Boron

Boron is not physiologically important to humans or stock in the concentrations normally encountered in natural waters: Hem (1959) considers concentrations above 10 ppm are very unusual and generally are derived from thermal springs. However, even though boron is a necessary trace element for

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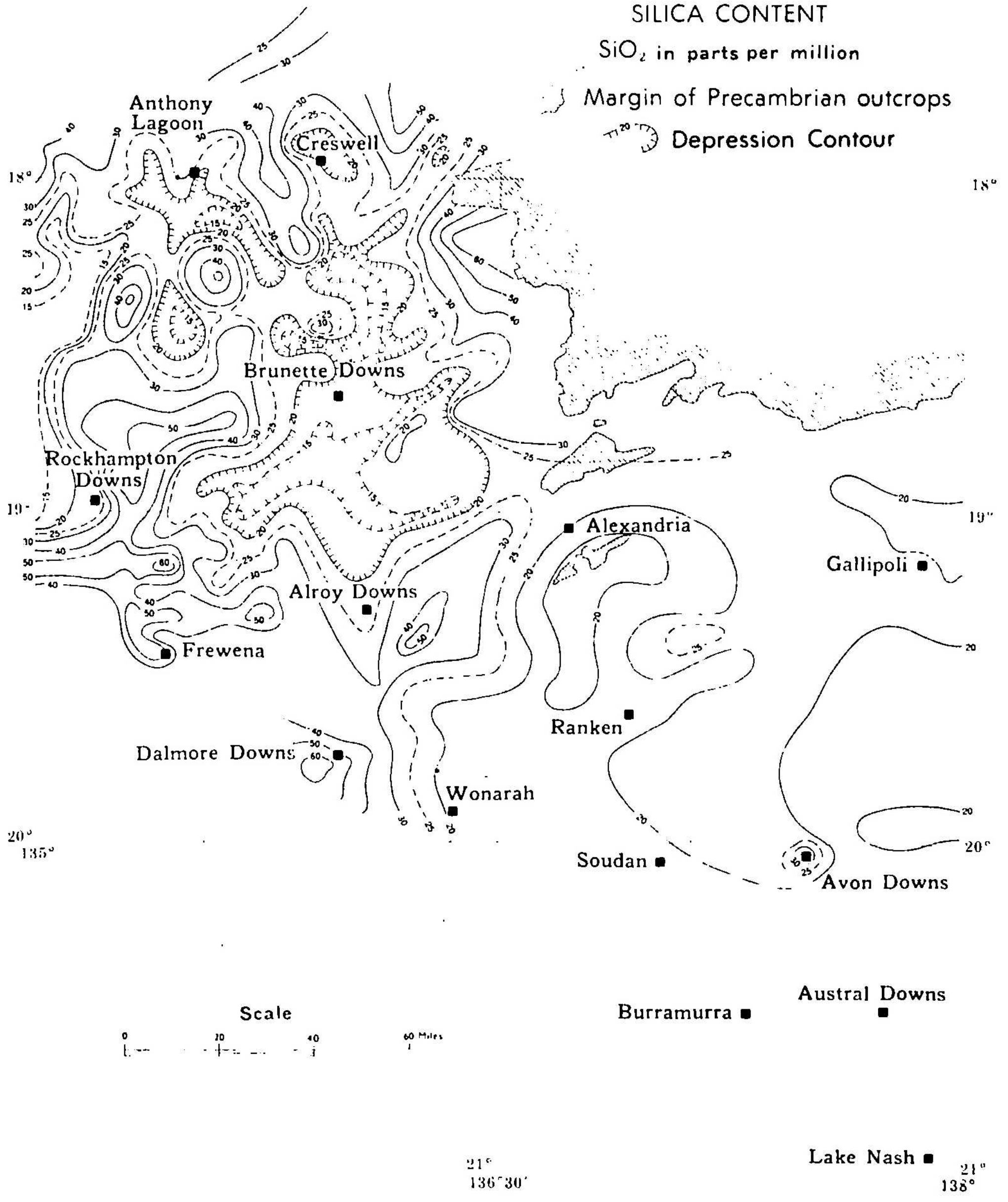
+ Originally Barkly Highway No. 18A.

Figure 18

WATER BORES STUDY
BARKLY TABLELAND

SILICA CONTENT

SiO_2 in parts per million



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plant growth, concentrations above 1 ppm are toxic to some plants; concentrations greater than 3.75 ppm render a water unsuitable for the irrigation of all crops. Average sea water contains 4.6 ppm of boron.

Boron, as calcium or sodium borate, is present in evaporite deposits and in complex silicates, notably tourmaline, in igneous and metamorphic rocks. The origin of the boron in the bore-waters of the Barkly Tableland is probably evaporitic interbeds in the carbonate sequence. Boron concentrations in the bore-waters are very low: 109 samples were analyzed for boron, the concentrations of which range from 0.1 ppm for Alexandria No. 16 (R.N. 751) to 2.77 ppm for Brunette Downs No. D14 (R.N. 1998).

The distribution of the boron concentrations has been plotted, but because of the small number of samples involved, no clearly defined trends have been observed. However, a few empirical observations have been noted and are presented here. Of the twelve values plotted in the eastern part of the region, only three are above 0.2 ppm and the maximum is 0.26 ppm. Values greater than 1 ppm mainly occur in the central part of the region, broadly in the areas of higher salinity and lower hydrodynamical gradient. Values greater than 2.0 ppm are confined to a small area about the western part of Lake Sylvester. Values in the western part of the region are low, generally less than 0.5 ppm. Generally the higher boron values are associated with waters high in sodium; the relationship is empirical, but is better defined than the relationship between boron and TDS.

Lithium

Lithium is rare in natural waters. In the bore-waters of the Barkly Tableland the maximum concentration is 0.4 ppm in Anthony Lagoon No. 7 (R.N. 602). Only 71 samples were analyzed for lithium: in 21 of these the lithium content was below the detection limit of 0.05 ppm, and in seven lithium was detected at this concentration limit. Because of the numerical paucity of samples, only empirical observations are possible. Twelve samples from bores in the eastern part of the region did not contain sufficient lithium for detection. Values between 0.1 ppm and 0.4 ppm lie mainly in a belt which extends from east of Anthony Lagoon Homestead through Brunette Downs Homestead to Alroy Downs Homestead and Frewena. The higher values are associated with areas of higher salinities, but the main trend is displaced a few miles to the west. Until detailed analyses of aquifer rocks are available, no chemical relationship between aquifer and lithium content of the bore-waters can be postulated.

Lead

Lead is toxic to humans and stock; Rainwater & Thatcher (1960) report the upper limits for domestic and stock waters as 0.1 ppm and 0.5 ppm, respectively. Seventy-one bore-waters were tested for lead, but only two yielded positive results; the lead concentration in these was at the detection limit of 0.01 ppm. Since the samples tested are considered to be representative of the region, it seems unnecessary to do additional lead analyses for either agricultural or geochemical purposes.

Aluminium

Aluminium is not known to be toxic to humans or stock; except in very high concentrations it is not important in irrigation waters. Water samples from 109 bores were analyzed for aluminium. Aluminium was detected in 49 samples at or above the detection limit of 0.02 ppm: 80 percent of these contain concentrations less than 0.1 ppm.

Values higher than 0.1 ppm occur in a belt between Creswell Downs Homestead and Kennedy Creek in the central part of the region; this belt corresponds approximately to the areas of higher salinity values. The aluminium analyses at present provide no useful interpretative date.

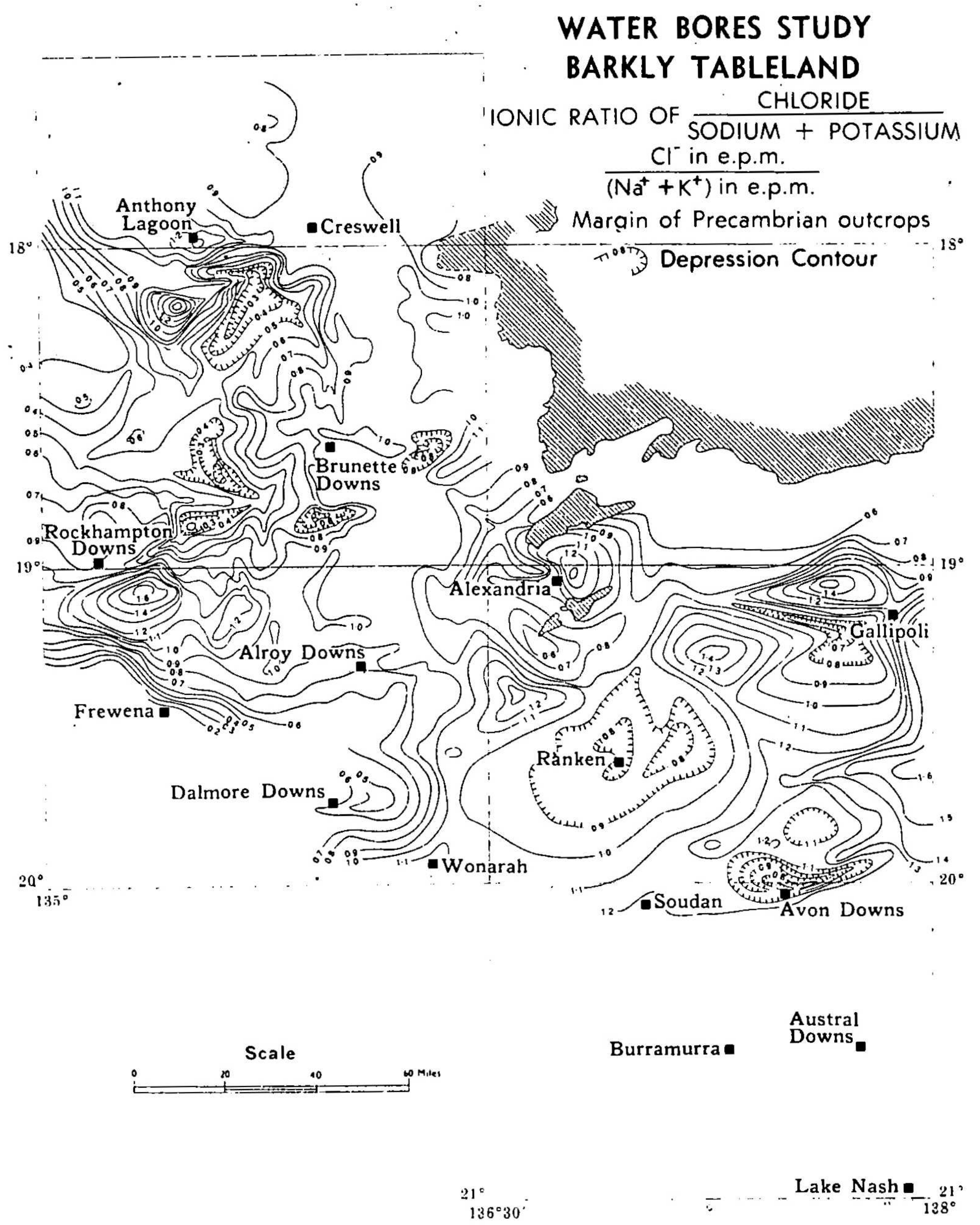
Iron and Manganese

Rainwater & Thatcher (1960) give the recommendation by the U.S. Public Health Service that the concentration of iron and manganese should not exceed 0.3 ppm for domestic water supplies. The limit is not based on the toxicity of these metals but rather on palatability; also these metals can cause objectionable and unpleasant deposits on food cooked in water. Stock also are sensitive to the taste imparted to water by these metals. The concentration of iron in irrigation waters is unimportant but crops have widely varying tolerances to manganese. In the bore-waters of the Barkly Tableland the highest concentration of iron yet encountered is 0.2 ppm, and for manganese 0.04 ppm. No interpretation can be based at present on the distribution of the values.

Phosphate

Seventy one samples were analysed for phosphate ($PO_4^{\equiv}$), but in only 15 was the concentration above the detection limit of 0.001 ppm. Most values were 0.01 ppm and the maximum was 0.03 ppm. It seems pointless to analyze

Figure 19



WATER BORES STUDY
BARKLY TABLELAND

IONIC RATIO OF $\frac{\text{CHLORIDE}}{\text{SODIUM + POTASSIUM}}$

$$\frac{Cl^- \text{ in e.p.m.}}{(Na^+ + K^+) \text{ in e.p.m.}}$$

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additional samples for phosphate in this region.

Nitrate and Nitrite

Nitrate and nitrite determinations are frequently made on domestic waters as they are an indication of possible pollution; in addition nitrogen as nitrate can cause cyanosis in infants (Hem, 1959). The recommended limit for nitrate nitrogen in drinking water is about 10 ppm nitrogen, i.e. 44 ppm of nitrate. Two bore-water samples were close to this figure viz: Brunette Downs No. 26 (R.N. 116) which contained 42.6 ppm and Rockhampton Down's No. 30 (R.N. 2940) which actually exceeds it with 46.8 ppm, however fewer than five percent of the bore-water samples contained more than 20 ppm of nitrate.

The origin of nitrogen in the samples is speculative: it presumably originates from chemical and bacterial action involving nitrogen in the soil.

IONIC RATIOS

Chloride/(Sodium + Potassium)

The ionic ratio $Cl^-/(Na^+ + K^+)$ of the bore-waters ranges from 0.18 in Brunette Downs No. D42 (R.N. 4052) to 1.7 in Rockhampton Downs No. 4 (R.N. 395). (Pl. 12 and Fig. 19).

A marked constriction in the 0.9 contours east of Alroy Downs Homestead separates the region into two areas, but the division and the variations of the ratio values within the two areas are not as well-defined as with some of the other sets of contours. Although there is a tendency for the ratio to rise in the regional directions of groundwater flow, the variations are only remotely parallel to the variations of characteristics previously discussed, expecially the piezometric contours (Fig. 9) and the isosalinity contours (Fig 11).

The probable recharge area, the northward direction of groundwater flow, and the complementary rise in salinity about Anthony Lagoon Homestead, are reflected by the $Cl^-/(Na^+ + K^+)$ ratio. Similarly the recharge area between Brunette Downs and Rockhampton Downs Homesteads is reflected by the ionic ratio contours 0.3 to 0.6, but the shape and extent are different from that indicated in Figures 9 & 11. The south-westwards flow direction along the north-eastern margin of the basin is only vaguely indicated by this ionic ration, probably owing to the apparent eastward displacement of the 1.0 contour and the development of higher values along the south-eastern margin of the Brunette Downs Sheet area. Although these high values form part of a steady increase in the ratio north-westwards from near Alexandria Homestead, the orientation of the contours and the sudden reversal to a low value east of Brunette Downs Homestead does not agree with the main direction of groundwater flow as indicated by the piezometric surface and the change in salinity. The northward direction of flow in the south-western part of the region is reflected by an increase in the value of this ratio, but the disposition and shape of the ratio contours and those on the salinity and piezometric surface are slightly different: the westward direction of flow near Rockhampton Downs Homestead is not apparent in the contours of this ratio.

Although there is a general southward and eastward increase in the $Cl^-/(Na^+ + K^+)$ ratio in the Ranken Sheet area, which agrees with the general direction of groundwater flow in this part of the region, the shape of the contours bears little resemblance to any other contours.

These variations may be caused by unknown factors which vary the expected rate of change normally associated with hydraulic flow through an aquifer of constant composition. Obviously the most probable factor is a variation in the composition of the aquifer, but until adequate bore-logs are available very little appraisal of this variation can be made. The variation by its very presence confirms that the sequence is not entirely carbonate. The probable presence of evaporites in the sequence has been discussed earlier, and these could certainly produce a marked change in the expected ratio values.

If salt beds are present it would be expected that the solution of alkali (mainly sodium) and chloride would be more or less stoichiometric i.e. the ratio would be about unity, although some departure from unity might be expected because of matter dissolved before the waters entered the salt environment; viz the alkali increase could be expected to be greater than chloride in the carbonate rocks particularly in the recharge areas. This is generally the case: comparison between Figures 9, 11, and 19 shows the $Cl^-/(Na^+ + K^+)$ ratio is lowest in the recharge areas.

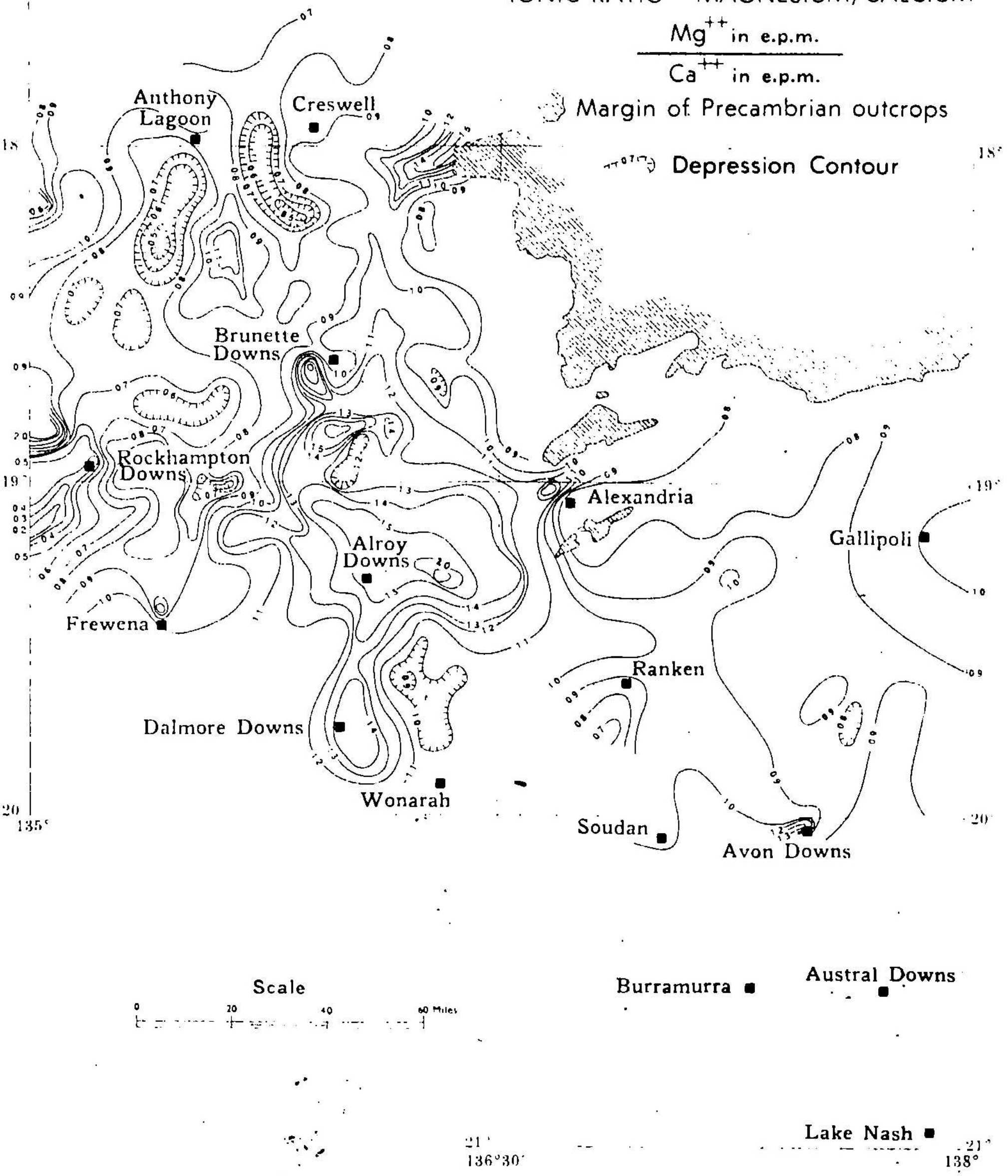
If it is assumed that a mainly stoichiometric increase of the two ions produces a ratio whose value lies between 0.9 and 1.1, an interesting observation can be deduced from Figure 19. The area outlined by the 0.9 and 1.1 contours forms a crescentic zone extending from near Anthony Lagoon Homestead

Figure 20

WATER BORES STUDY
BARKLY TABLELAND

IONIC RATIO MAGNESIUM/CALCIUM

$$\frac{Mg^{++} \text{ in e.p.m.}}{Ca^{++} \text{ in e.p.m.}}$$



To accompany Record 1966/11

eastward to Creswell Downs Homestead, southward to Alroy Downs Homestead, and thence westward to beyond Rockhampton Downs Homestead. This zone broadly reflects the area of high salinity, low hydraulic gradient, and areas of chloride and sulphato-chloride types of water. The area outlined by the 0.9 and 1.1 contours in the south-eastern part of the region does not form a pattern obviously related to other characteristics.

Areas where the ionic ratio exceeds 1.1 occur near Anthony Lagoon, Rockhampton Downs and Alexandria Homesteads, and in the south-eastern part of the region. The values in these areas, although mainly consistent with the direction of groundwater flow, indicate a much higher occurrence of chloride than alkalis. To maintain chemical equilibrium other cations must be in solution; these are calcium and magnesium ions in excess of what is needed to maintain chemical equilibrium with bicarbonate and sulphate ions. The implication is that magnesium and/or calcium ions are associated with chloride ions. This association is hard to visualize in an essentially carbonate sequence, and the presence of evaporites in the sequence is a possible explanation.

Magnesium/Calcium

The Mg^{++}/Ca^{++} ratio ranges from 0.2 in South Barkly Stock Route No. 9 (R.N. 504) to 2.62 in Alroy Downs No. 25 (R.N. 3139) (Fig. 20 and Pl. 13).

The changing values of this ratio cannot easily be related to the directions of groundwater flow. Near Gallipoli and Avon Downs Homestead and in the eastern parts of the Brunette Downs and Alroy Sheet areas, the ratio increases with increasing salinity in the direction of groundwater flow. An increase in the ratio north-west of Rockhampton Downs Homestead reflects an increase in salinity and the direction of flow, and low values of the ratio (about 0.6) reflect the recharge area north-east of Rockhampton Downs Homestead. In other areas there is a marked decrease in the value in the direction of flow, which tends to give the contour pattern a confused appearance which virtually has no similarity to the contours of characteristics previously discussed. There is no obvious demarcation of the region into two areas along the Wonarah-Alexandria line as in the case of other contour maps and the shape of the area of high values centred on Alroy Downs Homestead cannot be easily explained. Certainly the handiest explanation is the same as postulated for the anomalies in the $Cl^-/ (Na^+ + K^+)$ ratio i.e. varying composition of the aquifer rocks. The values of the Mg^{++}/Ca^{++} ratio will be affected by the amount of dolomite and dolomitic limestone in contact with the waters, but also by the solubility product $[Ca]\ [CO_3]$ and $[Ca]\ [SO_4]$ in the initial stages of groundwater circulation. In a simple dolomite it is difficult to visualize the groundwater dissolving an excess of Mg^{++} over Ca^{++} once the $[Ca]\ [CO_3]$ solubility product has been exceeded, since to dissolve further magnesium from the rock must involve the removal of further calcium. A further complication is the presence of HCO_3^- rather than $CO_3^=$, but notwithstanding this the magnesium must be coming from rocks with a magnesium content much higher than its calcium content, or at least a rock in which the magnesium is more readily available than is the calcium. It is not easy to explain the situation by postulating the precipitation of calcium salts to permit solution of further calcium and magnesium.

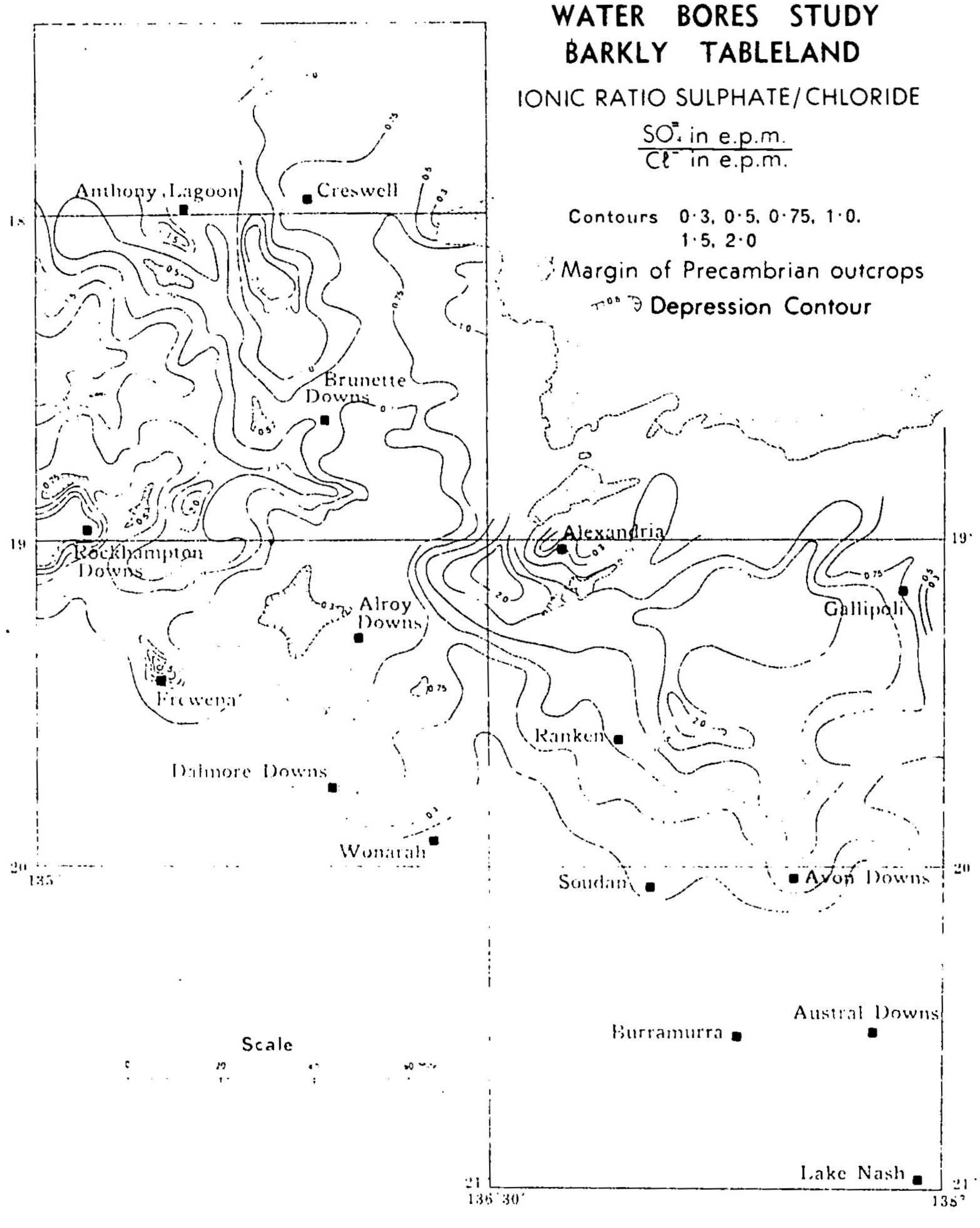
A possible explanation would be that the sequence contained evaporites.

Sulphate/Chloride

The ionic ratio $SO_4^=/Cl^-$ ranges from 0.14 in Avon Downs No. 3 (R.N. 340) to 8.37 in Rockhampton Downs No. 27 (R.N. 2234). However, values as high as 8.0 are rare: most of the high values are less than 5.0. (Fig. 21 and Pl. 14).

The ratio generally decreases with increasing salinity, and in the direction of groundwater flow, but, as in the case of the Mg^{++}/Ca^{++} ratio, the form lines do not divide the region into two distinct areas. As might be expected the lower values occur in areas of mainly chloride waters, but there are sufficient anomalies to suggest that factors other than hydraulic flow control the value of this ionic ration. The 0.5 contour outlines an area of low values extending from near Brunette Downs Homestead southward to Dalmore Downs Homestead, where it bifurcates - one arm eastward to Avon Downs Homestead and beyond - and the other westward to south of Rockhampton Downs Homestead. The eastern arm fits a normal pattern inasmuch as it becomes part of a sequence of decreasing ratios in the regional direction of groundwater flow, but the western arm does not. The piezometric surface and the salinity indicate a regional northward flow about Frewena, but the $SO_4^=/Cl^-$ ratio increases in this direction. On the other hand this northward increase becomes normal again as it continues rising into the recharge area

Figure 21



WATER BORES STUDY
BARKLY TABLELAND

IONIC RATIO SULPHATE/CHLORIDE

$\frac{SO_4^= \text{ in e.p.m.}}{Cl^- \text{ in e.p.m.}}$

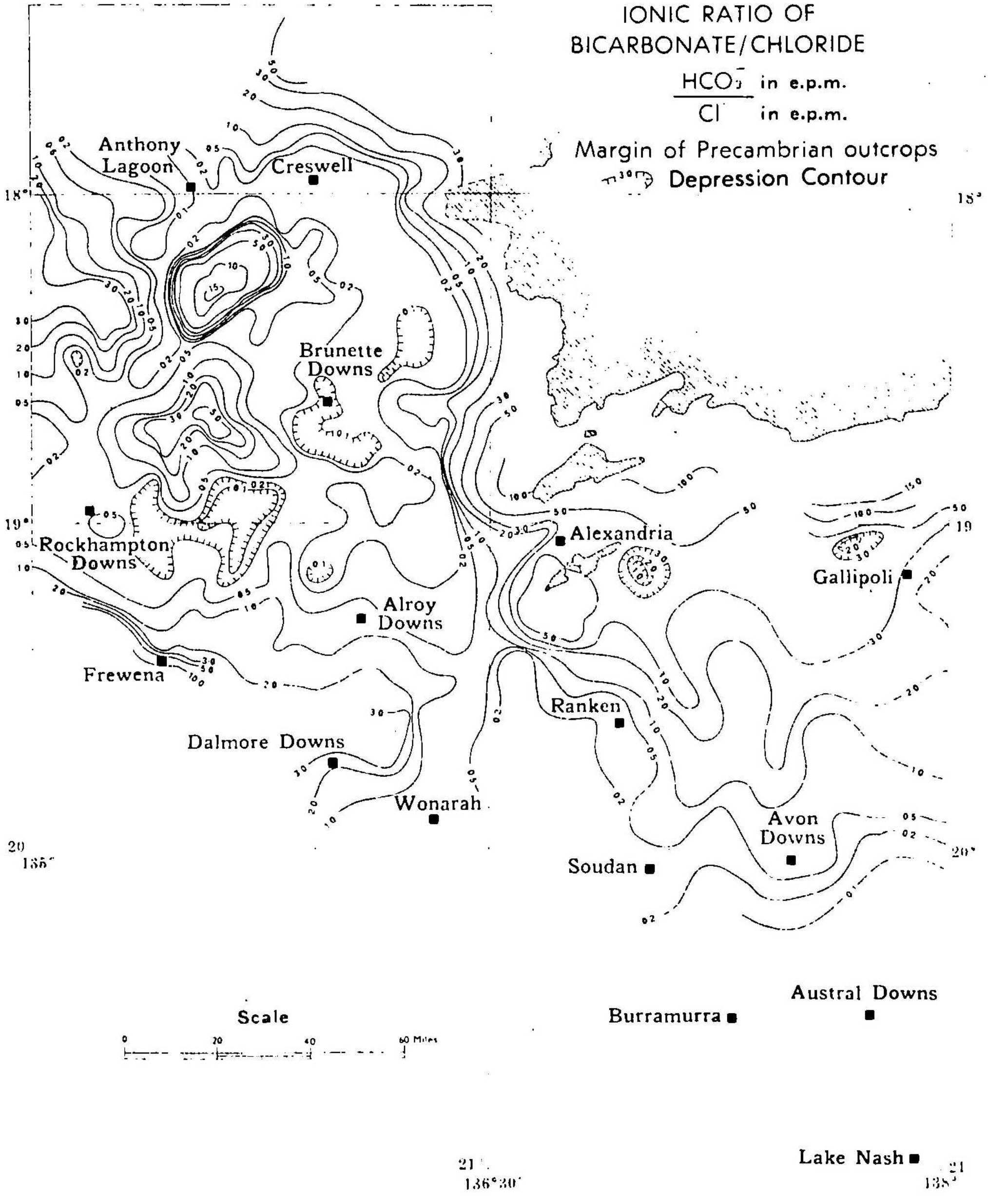
To accompany Record 1966/11

Figure 22

WATER BORES STUDY BARKLY TABLELAND

IONIC RATIO OF BICARBONATE/CHLORIDE

$\frac{HCO_3^-}{Cl^-}$ in e.p.m.



To accompany Record 1966/11

WATER BORES STUDY
BARKLY TABLELAND

Figure 23

IONIC RATIO in e.p.m.OF (CALCIUM + MAGNESIUM) / (SODIUM POTASSIUM)

$$\frac{Ca^{++} + Mg^{++}}{Na^{+} + K^{+}}$$

Contours 0·2, 0·5, 0·75, 1·0, 1·5, 2·0, 5·0, 10·0,

Margin of Precambrian outcrops

Depression Contour

To accompany Record 1966/11

outlined by previous characteristics between Rockhampton Downs and Brunette Downs Homesteads. Anomalous trends also occur west of Rockhampton Downs Homestead, north-east and east of Creswell Downs Homestead, and about Alexandria Homestead.

The low $SO_4^{=}/Cl^{-}$ values and high Mg^{++}/Ca^{++} values about Alroy Downs Homestead suggest an association of Mg^{++} with Cl^{-} and of Ca^{++} with $SO_4^{=}$. The association Ca^{++} with $SO_4^{=}$ is known in the region with the occurrence of gypsum ($CaSO_4.2H_2O$) in the black soils and reported by drillers from some of the water-bores.

Bicarbonate/Chloride

The ionic ratio HCO_3^{-}/Cl^{-} ranges from 0.01 in Alroy Downs No. 2 (R.N. 720) to 18.21 in Alexandria No. 39 (R.N. 3129)(Fig. 22 and Pl. 15). The contours clearly reflect the division of the region into two major groundwater areas with a constriction of the 1.0 contours and the ridge of high values between Dalmore Downs and Alexandria Homesteads. The ratio values reflect the major directions of groundwater flow: the ratio decreases with increasing salinity, and reflects the geochemical type of water based on anionic content.

(Calcium + Magnesium)/(Sodium + Potassium)

The ionic ratio $(Ca^{++} + Mg^{++})/(Na^{+} + K^{+})$ ranges from 0.5 in several discrete areas between Alroy Downs and Anthony Lagoon Homesteads to 10.0 north of Gallipoli Homestead (Fig. 23).

A constriction in the 1.0 contour along a line from Dalmore Downs to Alexandria Homesteads tends to divide the region into two areas of groundwater circulation, but the division is not well defined. Generally the ratio declines in the direction of groundwater flow and increasing salinity but local anomalies occur. These anomalies suggest that in some areas at least the ratio value is controlled by aquifer composition rather than hydraulic conditions. The most striking anomalies are near Frewena and Anthony Lagoon Homestead where northward directions of flow and increasing salinities are accompanied by a rise in the $(Ca^{++} + Mg^{+})/(Na^{+} + K^{+})$ value.

CHEMICAL TYPES OF WATER

Two hundred and sixty-five (265) bore-waters have been chemically analysed and the results used to classify the waters into three main chemical groups. The major classification has been based on the anionic content - i.e. whether the waters contain chloride (Cl^{-}), sulphate ($SO_4^{=}$), or bicarbonate

(HCO_3^-) as the dominant anion. Each group is divided into three types based on the nature of the next dominant anion and its value relative to the most dominant anion. For example, the Chloride group has been subdivided into i) mainly Chloride, ii) Sulphato-chloride, and iii) Bicarbonate-chloride types in which the following relationships hold:-

i) $Cl^- > HCO_3^- > SO_4^=$

ii) $Cl^- > SO_4^= > HCO_3^-$, but $Cl^- - SO_4^=$ is not greater than 20 percent of total anionic content.

iii) $Cl^- > HCO_3^- > SO_4^=$, but $Cl^- - HCO_3^=$ is not greater than 20 percent of the total anionic content.

Similarly, the types derived from the sulphate and bicarbonate groups have similar anionic relationships.

Figure 24 illustrates the spatial distribution on the various water types in the region, and Figure 13a and Table 6 indicate the numerical distribution based on the number of samples analyzed. The apparent discrepancy between Figures 24 and 13a is due to the greater density of bores on Brunette Downs station, an area of mainly chloride group waters.

TABLE 6

Numerical distribution of Chemical Types of Groundwater

DOMINANT ANION / SECONDARY ANION	CHLORIDE	SULPHATE	BICARBONATE	
CHLORIDE	MAINLY CHLORIDE (A) 66	CHLORO-SULPHATE (BA) 19	CHLORO-BICARBONATE (CA) 19	104
SULPHATE	SULPHATO-CHLORIDE (AB) 61	MAINLY SULPHATE (B) 15	SULPHATO-BICARBONATE (CB) 8	84
BICARBONATE	BICARBONO-CHLORIDE (AC) 22	BICARBONO-SULPHATE (BC) 6	MAINLY BICARBONATE (C) 49	77
TOTALS	149	40	76	265

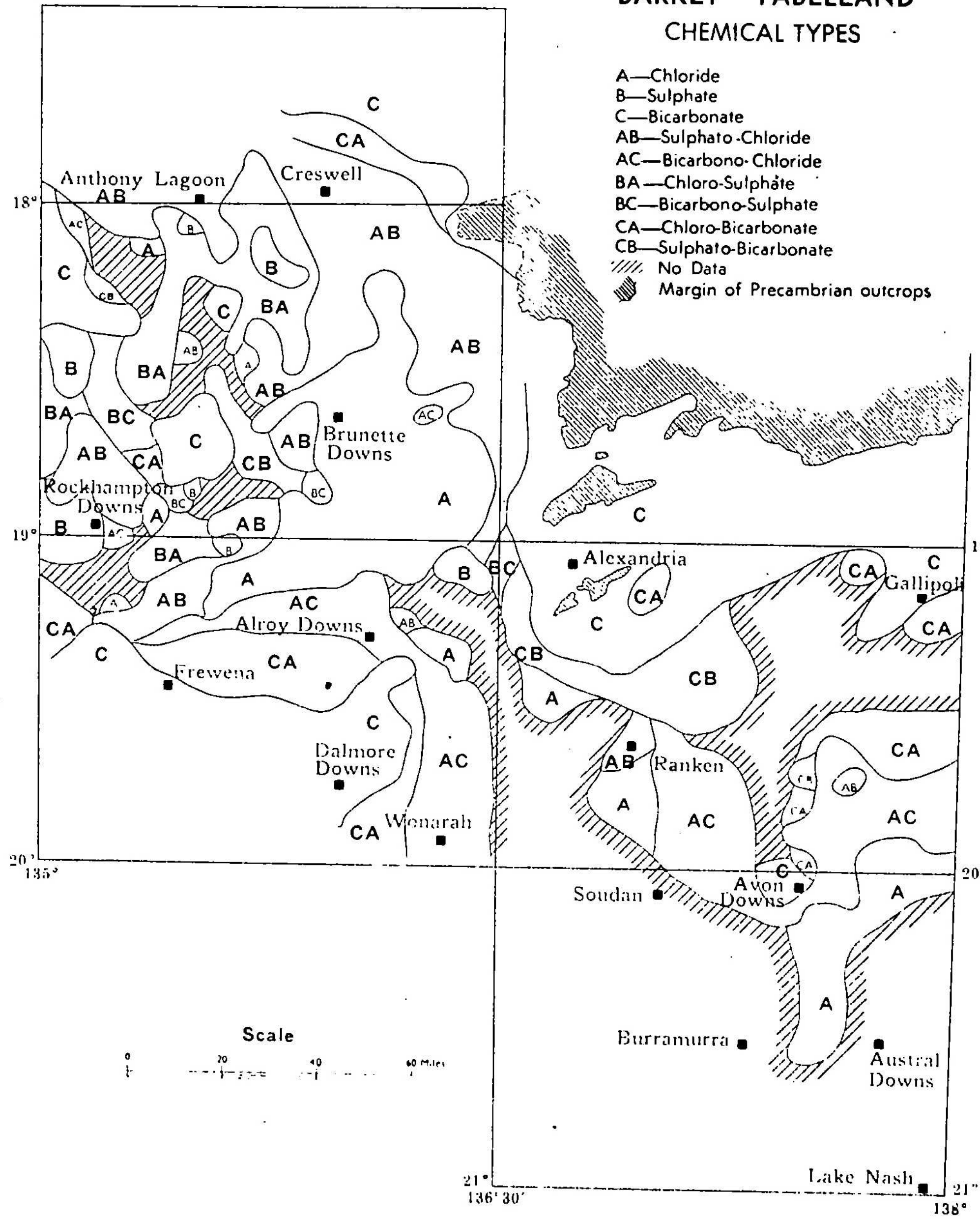
(A, AB, AC etc. refer to symbols in Appendices, Plates and Figures).

The types have been further divided into 31 classes illustrated in Figure 25. The division is based on the cationic content of the bore-water, but at present no analysis has been made of the cationic distribution other than the ionic ratios previously discussed. The composition of the classes is

Figure 24

WATER BORES STUDY BARKLY TABLELAND

CHEMICAL TYPES



A—Chloride
B—Sulphate
C—Bicarbonate
AB—Sulphato-Chloride
AC—Bicarbono-Chloride
BA—Chloro-Sulphate
BC—Bicarbono-Sulphate
CA—Chloro-Bicarbonate
CB—Sulphato-Bicarbonate
▨ No Data
▨ Margin of Precambrian outcrops

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briefly described below:

Chloride Group

i) Mainly chloride waters

The mainly chloride types have been classified into two classes based on the relative amounts of magnesium and calcium. In both classes the sodium content is far greater than either magnesium or calcium, and the waters have been included in the mainly sodium class on Figure 13b. They are shown on Figure 25 as classes Anm and Anc.

Class Anm: for these waters the magnesium content is usually greater than, but in a few samples equal to, the calcium content. An average composition, based on 46 samples is as follows:

Cations		Anions	
Sodium (including Potassium)	50 percent	Chloride	61 percent
Calcium	18 "	Bicarbonate	12 "
Magnesium	23 "	Sulphate	27 "

Class Anc: for these waters the calcium content is greater than that for magnesium. An average composition based on 16 samples is as follows:

Cations		Anions	
Sodium (including Potassium)	56 percent	Chloride	55 percent
Calcium	23 "	Bicarbonate	15 "
Magnesium	21 "	Sulphate	31 "

A further four samples of mainly chloride waters in which sodium is the dominant cation could not be classified as the magnesium and calcium content were not determined. These are shown in Appendix D under Avon Downs Sheet area.

Distribution of mainly chloride types: the chloride types occur mainly in the central part of the region in an area which extends from south of Creswell Downs Homestead southwards to near Alroy Downs Homestead, thence south-westward to near Frewena. Chloride-type waters occur also between Soudan Homestead and Ranken store, between Ranken store and Alroy Downs Homestead, and between Avon Downs and Austral Downs Homesteads. Small isolated areas occur between Anthony Lagoon Homestead and Frewena.

ii) Sulphato-chloride waters

The sulphato-chloride waters are those in which chloride is the dominant anion, but the sulphate ion has assumed some importance. The waters have been divided into three classes - ABnm, ABnc, and ABcn. For the first two sodium is the dominant cation and these waters are included under 'mainly sodium' in Figure 13b.

Class ABnm: for these waters the magnesium content is usually slightly higher than calcium, but for three samples the values are the same. An average composition based on nine samples is:

Cations		Anions	
Sodium (plus Potassium)	63 percent	Chloride	52 percent
Calcium	18 "	Bicarbonate	10 "
Magnesium	19 "	Sulphate	38 "

Class ABnc: these waters account for the greatest number of bore-waters for which analyses are available. The class contains 50 samples and makes the sulphato-chloride waters the largest type, and together with the 66 samples of mainly chloride type helps make the chlorides the largest group. In this class calcium content is higher than magnesium content, and this reflects the association of calcium ion and sulphate ion - an association further high-lighted in the sulphate group and sulphato-bicarbonate type. The average composition is:

Cations		Anions	
Sodium (plus Potassium)	54 percent	Chloride	48 percent
Calcium	24 "	Bicarbonate	13 "
Magnesium	22 "	Sulphate	39 "

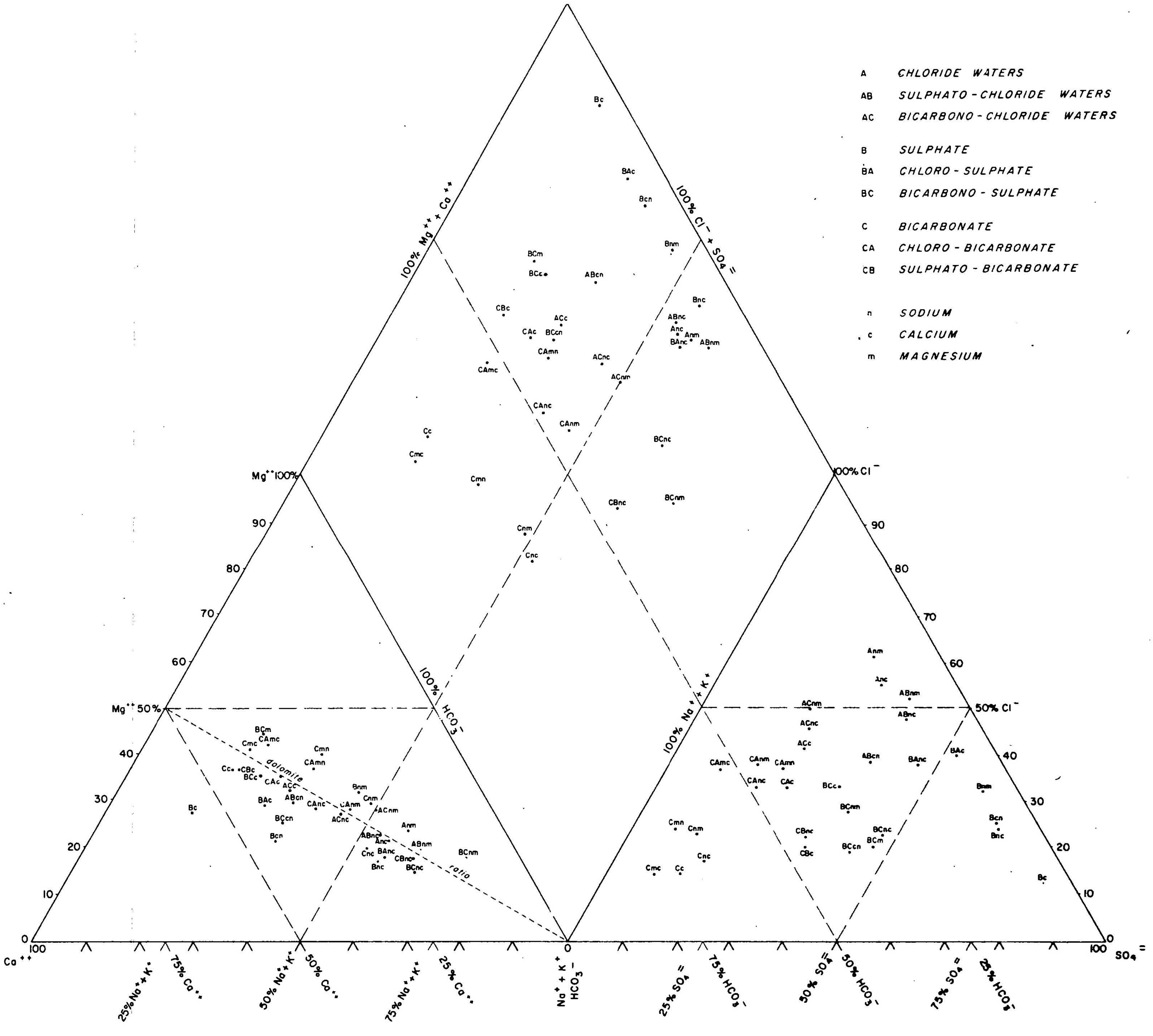
Class ABcn: only two samples occur in this class, and in both there is no clearly defined chemical characteristic. Although the waters are dominantly chloride the difference between the sulphate and bicarbonate content is small. Similarly, although the calcium content is greater than the sodium content the difference is small. The average analysis is:

Cations		Anions	
Sodium (plus Potassium)	34 percent	Chloride	39 percent
Calcium	37 "	Bicarbonate	24 "
Magnesium	29 "	Sulphate	27 "

Distribution of Sulphato-chloride waters: The sulphato-chloride waters are widespread. They occur in an area from Anthony Lagoon to Creswell Downs Homesteads and thence southwards to near Brunette Downs Homestead and south-eastwards along the north-eastern margin of the region. They occur in discontinuous areas southwards from Anthony Lagoon Homestead to near Frewena, and in an area around Ranken store. The area of mainly chloride-type waters in the central part of the region is encircled by sulphato-chloride waters

RELATIVE IONIC COMPOSITION OF THE CLASSES OF BORE - WATER

(BASED ON THE AVERAGE COMPOSITION OF EACH CLASS)



Bureau of Mineral Resources, Geology and Geophysics. March 1965 To accompany Record 1966/11 NT/A/94 except in the south.

iii) Bicarbono-chloride waters

The bicarbono-chloride waters have been divided into three classes - ACnm, ACnc, and ACc. In the first two sodium is the dominant cation. Class ACnm: for these waters the magnesium content is usually greater than that for calcium, but in two samples the two are equal. An average composition based on 9 analyses is as follows:

Cations		Anions	
Sodium (plus Potassium)	50 percent	Chloride	50 percent
Calcium	22 "	Bicarbonate	30 "
Magnesium	28 "	Sulphate	20 "

Class ACnc: in this class calcium content is slightly greater than the magnesium content. An average composition based on 8 samples is:

Cations		Anions	
Sodium (plus Potassium)	44 percent	Chloride	46 percent
Calcium	29 "	Bicarbonate	32 "
Magnesium	27 "	Sulphate	22 "

Class ACc: classes ACc and ABcn, represented by 5 samples and 2 samples respectively, are unusual inasmuch as they are the only waters of the chloride group - a total of 149 samples - in which the calcium ion has a dominant role. But it is noteworthy that its dominance is only a slim one in both cases. For class ACc sodium content is slightly higher or equal to that for magnesium. An average analysis for class ACc waters is:

Cations		Anions	
Sodium (plus Potassium)	32 percent	Chloride	42 percent
Calcium	36 "	Bicarbonate	35 "
Magnesium	32 "	Sulphate	23 "

Distribution of bicarbono-chloride waters: this type of water occurs mainly in the southern and south-eastern part of the region in a thin crescentic area from north of Frewena eastward to Alroy Downs Homestead, and thence southwards to Wonarah, and in a U-shaped area from Ranken store to Avon Downs Homestead and thence to the Queensland border. Very small areas occur south-west of Anthony Lagoon Homestead, east of Rockhampton Downs Homestead and east of Brunette Downs Homestead.

Sulphate Group

i) Mainly sulphate waters

The mainly sulphate waters have been classified into four classes, totalling 15 samples. In none of the samples is magnesium the dominant cation, and for all of them the bicarbonate content is very low. The characteristics of the classes - Bc, Bcn, Bnc, and Bnm - are as follows:

Class Bc: for this class the calcium content is much higher than the magnesium content. The sodium content is low. An average composition based on 5 samples is:

Cations		Anions	
Sodium (plus Potassium)	16 percent	Chloride	13 percent
Calcium	57 "	Bicarbonate	5 "
Magnesium	27 "	Sulphate	82 "

Class Bcn: this class contains 3 samples: calcium content is higher than that for sodium, magnesium content is low. The average composition is:

Cations		Anions	
Sodium (plus Potassium)	35 percent	Chloride	26 percent
Calcium	44 "	Bicarbonate	7 "
Magnesium	21 "	Sulphate	67 "

Class Bnc: in this class the sodium content is much higher than the calcium content - greater than 2:1, and the Mg^{++}/Ca^{++} value is about 0.6. The average composition, based on five samples is as follows:

Cations		Anions	
Sodium (plus Potassium)	56 percent	Chloride	25 percent
Calcium	27 "	Bicarbonate	7 "
Magnesium	17 "	Sulphate	68 "

Class Bnm: this class contains only two samples: the average composition is:

Cations		Anions	
Sodium (plus Potassium)	45 percent	Chloride	33 percent
Calcium	23 "	Bicarbonate	6 "
Magnesium	32 "	Sulphate	61 "

Distribution of the mainly sulphate waters: this water type occurs in small isolated areas near Rockhampton Downs Homestead, near Anthony Lagoon Homestead, and west of Alexandria Homestead. It usually occurs close to areas of chloride or sulphato-chloride types of groundwater, and may be explained by a local concentration of gypsum in the aquifers.

ii) Chloro-sulphate waters:

The chloro-sulphate waters contain 19 samples in two classes. The rising influence of the chloride ion is reflected by the sodium content, which, in its relationship to the calcium content, has been used for the classification. It is noteworthy that in the sodium-rich class (BAnc) the disparity between the chloride and the sulphate contents is much less than in the sodium-poor class (BAc), thereby suggesting an association of sodium and chloride ions.

<u>Class BAnc</u>: the average composition of this class, based on 15 samples, is:

Cations		Anions	
Sodium (plus Potassium)	56 percent	Chloride	39 percent
Calcium	26 "	Bicarbonate	15 "
Magnesium	18 "	Sulphate	46 "

<u>Class BAc</u>: the average composition of this class, based on four samples, is:

Cations		Anions	
Sodium (plus Potassium)	29 percent	Chloride	41 percent
Calcium	42 "	Bicarbonate	7 "
Magnesium	29 "	Sulphate	52 "

<u>Distribution of Chloro-sulphate waters</u>: these waters occur in one large and two small areas in the western part of the region. The areas are marginal to areas of mainly sulphato-chloride and sulphate type waters.

iii) Bicarbono-sulphate waters

The bicarbono-sulphate waters are numerically the least important of the groundwaters of this region. The type contains five classes - BCnm, BCnc, BCcn, BCm, and BCc.

<u>Class BCnc</u>: the average composition of this class based on two samples, is:

Cations		Anions	
Sodium (plus Potassium)	64 percent	Chloride	24 percent
Calcium	21 "	Bicarbonate	29 "
Magnesium	15 "	Sulphate	47 "

<u>Classes BCnm, BCcn, BCm, and BCc</u> contain one sample each: the analyses are given in Appendices C and D under the following respective registered numbers R.N. 2580 on Brunette Downs Sheet, R.N. 396 on the Alroy Sheet, and R.N.2486 and R.N. 96 on the Ranken Sheet.

<u>Distribution of bicarbono-sulphate waters</u>

The bicarbono-sulphate waters occur in four small areas - south of Brunette Downs Homestead, between Brunette Downs and Rockhampton Downs Homesteads, west of Alexandria Homestead, and near Frewena - and in a medium-sized area north of Rockhampton Downs Homestead.

<u>Bicarbonate Group</u>

i) Mainly bicarbonate waters.

The mainly bicarbonate waters have been divided into five classes - Cc, Cnm, Cnc, Cmc, and Cmn. With a total of 49 samples this type is numerically exceeded only by the mainly chloride and sulphato-chloride types. The bicarbonate ion makes up two-thirds or more of the total anionic content. The role of calcium ion is somewhat greater than that of sodium: magnesium generally is slightly less important than sodium.

Class Cc: for these waters calcium is slightly dominant over magnesium. The class composition of almost equal calcium and magnesium and low sulphate and chloride content suggests waters in contact with dolomitic rocks. An average composition based on 23 samples is as follows:

Cations		Anions	
Sodium (plus Potassium)	18 percent	Chloride	15 percent
Calcium	44 "	Bicarbonate	72 "
Magnesium	37 "	Sulphate	12 "

Class Cnm: in this class the chloride content has risen at the expense of bicarbonate, and the sodium content has greatly risen - mainly at the expense of calcium but also at the expense of magnesium. The average analysis for the class, based on eleven samples, is:

Cations		Anions	
Sodium (plus Potassium)	48 percent	Chloride	24 percent
Calcium	22 "	Bicarbonate	64 "
Magnesium	30 "	Sulphate	12 "

Class Cnc: for this class of nine samples, in which Na $>$ Ca $>$ Mg , the average composition is:

Cations		Anions	
Sodium (plus Potassium)	52 percent	Chloride	18 percent
Calcium	28 "	Bicarbonate	66 "
Magnesium	20 "	Sulphate	16 "

[illegible] numbers

Class Cmc: this class contains five samples, in which the bicarbonate content is very high, but the magnesium content is usually only slightly greater than that of calcium. The influence of dolomitic or dolomite aquifers is apparent. The average composition is:

Cations		Anions	
Sodium (plus Potassium)	20 percent	Chloride	14 percent
Calcium	39 "	Bicarbonate	77 "
Magnesium	40 "	Sulphate	9 "

Class Cmn: is represented by only one sample. The chloride content has sharply risen as has the sodium content which is only slightly exceeded by that of magnesium. The composition is:

Cations		Anions	
Sodium (plus Potassium)	34 percent	Chloride	24 percent
Calcium	26 "	Bicarbonate	68 "
Magnesium	40 "	Sulphate	8 "

<u>Distribution of mainly bicarbonate waters</u>: the importance of the mainly bicarbonate waters is reflected in their areal distribution. They occur along the northern, north-eastern, north-western and south-western margins of the region, in two discrete areas between Anthony Lagoon Homestead and Frewena, and in a small area about Avon Downs Homestead. Geochemically they are a very important type as they are usually of low salinity. Their position in relation to the groundwater evolution is discussed later in this chapter.

ii) Chloro-bicarbonate waters

The chloro-bicarbonate waters have been divided into five classes representing nineteen samples. Although a cationic classification of the type is obvious there is not a great difference between the values of the most dominant cation and the next dominant cation except in the sodium class. For most of the samples the difference between the bicarbonate and chloride contents is not great.

<u>Class CAc</u>: in this class calcium is dominant over magnesium and sodium. The average composition, based on seven samples is:

Cations		Anions	
Sodium (plus Potassium)	28 percent	Chloride	34 percent
Calcium	39 "	Bicarbonate	42 "
Magnesium	33 "	Sulphate	24 "

<u>Class CAnm</u>: this class, in which sodium is the dominant cation, contains eight samples. The average composition is:

Cations		Anions	
Sodium (plus Potassium)	45 percent	Chloride	39 percent
Calcium	26 "	Bicarbonate	45 "
Magnesium	29 "	Sulphate	16 "

<u>Class CAnc</u>: this class contains two samples of average composition as follows:

Cations		Anions	
Sodium (plus Potassium)	39 percent	Chloride	33 percent
Calcium	33 "	Bicarbonate	48 "
Magnesium	28 "	Sulphate	19 "

<u>Classes CAmc and CAmn</u>: as the suffixes indicate the classes are those in which magnesium content is dominant over calcium and sodium. There is one

sample in each class.

Distribution of chloro-bicarbonate waters: the chloro-bicarbonate type is widely distributed. It occurs in a restricted belt in the north-east, and as a discontinuous belt from west of Frewena eastwards to Alroy Downs and thence southwards to near Wonarah. It occurs in a discontinuous belt in the eastern part of the region from Avon Downs to Gallipoli Homesteads. Small discrete areas of this type occur near Rockhampton Downs, Alexandria and Gallipoli Homesteads.

iii) Sulphato-bicarbonate waters

The sulphato-bicarbonate waters, together with the bicarbono-sulphate waters, are unimportant. The sulphato-bicarbonate type is divided into two classes - CBc and CBnc - and contains a total of eight samples. The increase in sulphate content has been mainly at the expense of bicarbonate rather than chloride. Calcium is the most important cation, and sodium the least, despite its dominance in class CBnc.

Class CBc: this class contains six samples. The average composition is:

Cations		Anions	
Sodium (plus Potassium)	30 percent	Chloride	21 percent
Calcium	43 "	Bicarbonate	45 "
Magnesium	37 "	Sulphate	34 "

Class CBnc: this class is sodium rich with calcium only slightly greater than magnesium. The anionic differences are not great. An average composition from two analyses is:

Cations		Anions	
Sodium (plus Potassium)	62 percent	Chloride	23 percent
Calcium	20 "	Bicarbonate	44 "
Magnesium	18 "	Sulphate	33 "

Distribution of the sulphato-bicarbonate waters: the sulphato-bicarbonate waters have a restricted areal extent. They are marginal to a large area of bicarbonate waters south of Alexandria Homestead where they act as a buffer between these waters and chloride group waters to the south. They occur in a similar geochemical environment in a small area west of Brunette Downs Homestead.

Chemical type as a function of groundwater environment

Schoeller (1959, p. 67) in discussing the progressive changes in the mineralization of groundwater states; 'that water completely changes its nature approximating progressively to a type of composition:

$rCl > rSO_4 > rCO_3$, and $rNa > rMg > rCa$ ', where the prefix '+' indicates the values are expressed as milli-equivalents per litre (equivalents per million). Further he quotes (p. 74) the Ignatovitch-Souline sequence as applied to vertical zonation as:

$$' \; HCO_3^- > HCO_3^-, \qquad SO_4^= > SO_4^= Cl^- > Cl^- SO_4^= > Cl^- \; '.$$

Chebotarev (1955, p. 203) reports his findings in similar vein: 'Because of the different mobility of the chemical elements and the nature of the physical-chemical processes in the subsurface reservoir, the geochemical types of water change with the increase of the total salinity as well as with increasing depth, and the following series holds good:

$$HCO_3^- \rightarrow HCO_3^- + Cl^- \rightarrow Cl^- + HCO_3^- \rightarrow Cl^- + SO_4^= \text{ or } SO_4^= + Cl^- \rightarrow Cl^-;$$

This sequence is correct in vertical zones as well as in the horizontal zones of subterranean waters '.

The two ideas above may be expanded in the following way for the anionic changes:

$$\begin{tikzcd}
HCO_3^- \arrow[r] \arrow[dr] & HCO_3^- + SO_4^=. \arrow[r] & SO_4^= + HCO_3^- \arrow[r] & SO_4^= + Cl^- \arrow[r] & Cl^- + SO_4^= \arrow[r] & Cl^- \\
 & HCO_3^- + Cl^- \arrow[r] & Cl^- + HCO_3^- \arrow[urrr] & & &
\end{tikzcd}$$

This series may be expressed in terms of the geochemical type symbols used in the Plates and Figures accompanying this report as:

$$\begin{tikzcd}
C \arrow[r] \arrow[dr] & CB \arrow[r] \arrow[d] & BC \arrow[r] & B \arrow[r] & BA \arrow[r] & AB \arrow[r] & A \\
 & CA \arrow[rrrr] & & & & AC \arrow[u] \arrow[ur] &
\end{tikzcd}$$

The series above is obviously a continuum between the two end members (dominant bicarbonate or dominant chloride) rather than an abrupt change from one type to another, and this is shown by the contours on the ionic ratios involving the anions. On the other hand the changes may be rapid because of aquifer composition or change in hydraulic gradients, and some types in the geochemical sequence may appear to be absent. In addition, in areas or belts of rapid change, the presence of a particular geochemical type may not be revealed because of few bores or few samples. These points should be borne in mind in the examination of Plate 16 and Figure 24 which illustrate the distribution of the geochemical types by outlining discrete areas.

If the geochemical type reflects the position of groundwater in the hydrodynamic environment then the change from bicarbonate waters to chloride waters should be in the direction of groundwater flow, and bicarbonate waters should be near recharge areas.

The distribution of geochemical types shown in Figure 24 conforms to the regional pattern of groundwater flow as evidenced by the contours on the piezometric surface (Fig. 9) and the isosalinity contours (Fig. 11). Slight aberrations are presumably due to changes in the geochemistry of the aquifers and also probably to intermingling of waters which have progressed through different phases of the geochemical evolution and the resultant water then progressively changing.

In the north-eastern part of the region the piezometric contours indicate a south-westward direction of groundwater movement, which is also a direction of increasing salinity: the geochemical trend here is C → CA → AB → A. The regional direction of water-movement in the south-western part is northwards, and here a salinity increase is accompanied by the expected geochemical evolution C → CA → AC → A. The northward flow about Anthony Lagoon Homestead has the chemical change C → AC → AB on the west and on the east B → BA → AB. A recharge area of low salinity and containing a closed high value piezometric contour west of Brunette Downs Homestead is reflected by a bicarbonate type water on Figure 24. In the direction of flow towards Frewena the change in chemical type is C → BC → BA → AB.

In the eastern part of the region the regional direction of groundwater flow as evidenced by the piezometric surface is from the Alexandria-Gallipoli area southwards towards Soudan and Lake Nash Homesteads. This is also the direction of increasing salinity, and the geochemical evolution is C → CB → AB → A towards Ranken store and C → CA → AC → A towards Austral Downs Homestead.

The low piezometric surface and consequent low gradients near Ranken store are reflected by high salinity and chloride (A) types; similarly high gradients in a small area about Avon Downs Homestead are reflected by bicarbonate (C) types with marginal chloro-bicarbonate (CA) types.

Both Schoeller (op. cit.) and Chebotarev (op. cit.) indicate that geochemical type is controlled by geological structure, in particular the depth of the aquifer. The contours on a hypothetical aquifer (Fig. 8; Pl.4) indicate that the lowest position of the aquifer is frequently in the area of highest progressive salinity, and vice versa. The relationship is not exact, probably because of the limitations on the validity of the aquifer map already discussed, and because of probable variations in aquifer composition and hydraulic gradients.

It has not been possible to relate the major geochemical types of water to any specific geological control by the individual Cambrian units. This is mainly because the entire Cambrian sequence of the region is a thin, widespread, and essentially uniform carbonate sequence at depth. The major geochemical control therefore has been through hydraulic environment, caused by the physical properties of the rocks and their structural position in relation to recharge areas. Even so, aquifer composition has some effect on the geochemistry of the groundwater in this region, and apparently anomalous variations in absolute values and ionic ratios have been discussed previously in this connexion. The problem cannot be solved until more detailed data are available on groundwater movement - i.e. speed and direction - and the subsurface geology in the area. and on aquifer composition. It appears that the major influence will be on cations rather than anions; however if the sequence of anion variation caused by the groundwater flow can be established, the anomalies through change of aquifer composition may become more accurately apparent, and therefore more readily usable for subsurface geological interpretation.

CONCLUSIONS

In the central and eastern parts of the Barkly Tableland considerable quantities of groundwater are available from aquifers in a Cambrian marine sequence of mainly carbonate rocks, with some siltstone and sandstone interbeds. Although correlation of aquifers from bore to bore is impossible at present, it is apparent that water is stored in several aquifers with some vertical interconnexion through cavities, joints, and fissures in the carbonate rocks. There is no evidence of aquifer depletion, and the comparison between the probable annual recharge and the maximum annual withdrawal indicates considerable reserves for further development of the pastoral industry.

The water is sub-artesian but a large area in the central part of the region contains groundwater in simulated unconfined conditions, but this water occurs in the shallower aquifers with restricted supplies. It appears to be confined groundwater which has leaked upward through cavities and other openings from deeper aquifers, and has adjusted itself to the regional piezometric surface.

The groundwater system is divided into two areas by a ridge in the piezometric surface generally directed south-westwards from near Alexandria Homestead to Wonarah Telegraph Station and Dalmore Downs Homestead. To the east of the ridge the hydraulic gradient is generally coincident with the drainage directions of the Georgina River Basin, and to the west the gradient is directed towards the Barkly Internal Drainage Basin, but some restricted flow occurs to the north-west and west.

The chemical evolution of the groundwater in the two areas is similar, but in the western area the salinity (up to 11,000 ppm) is much higher than in the eastern area (up to 2500 ppm). There is a distinct connexion between the groundwater flow, as indicated by the piezometric surface, and the salinity in terms of total dissolved solids. Contours of the salinity values clearly reflect the division of the groundwater system in two areas, and parallel the general trends of the piezometric surface. The same divisions are indicated to varying degrees by the individual ions and the ionic ratios. The chemical type of the groundwater, based on the anionic content, conforms to the pattern of groundwater flow and distribution: bicarbonate waters in recharge or near recharge areas and areas of low salinity; chloride waters in areas of semi-stagnation and low hydraulic environment, and areas of high salinity, and intermediate chemical types in areas of intermediate hydraulic environment.

The quality of the groundwater is extremely variable: the salinity ranges from 31 ppm to about 11,000 ppm; over much of the area it is unfit for human consumption, mainly because of high salinity, high sulphate content, or high fluoride content. In this respect the groundwater in the area of the Barkly Internal Drainage Basin is the most unsuitable, particularly in a crescentic belt from Creswell Downs Homestead to Alroy Downs Homestead and westward to near Rockhampton Downs Homestead, and in an irregularly arcuate and discontinuous belt from Anthony Lagoon Homestead to Rockhampton Downs Homestead. Very few bores have tapped water unsuitable for stock. Many of the bores are producing water of doubtful value for agriculture on the clayey black soils. The waters are generally high in sodium relative to magnesium and calcium, and the risk of soil deterioration is high. Should future development require water for agriculture, the shallow aquifers should be investigated as these reputedly contain better quality water.

The chemistry of the groundwater appears to be controlled mainly by hydraulic environment, but some control by aquifer composition is apparent particularly from the variations of the ionic ratios. The influence of aquifer composition may mainly affect the cation content of the groundwater, but should a sequence of anion variation caused by hydraulics be established, the anion anomalies caused by aquifer composition may become apparent and may provide a basis for subsurface interpretation.

Inasmuch as the chemistry of the groundwater reflects its hydraulic environment, which is partially a function of its position in the geological structure, there is some connexion between the geochemistry and the geological structure of the Barkly Tableland. The sets of profiles (Plate 17) show a close connexion between the surface topography, standing water level, depth of first aquifer, and the geochemistry; and a partial connexion between surface topography and depth to the main supply. The structural and lithological factors which have combined to produce the present physiography have presumably affected the disposition of the intake (recharge) areas relative to the present configuration of the rock sequence - and of the aquifers contained in it; this in turn has controlled the hydraulic environment and consequently the geochemistry. The groundwater is essentially a bicarbonate-type on the margins of the basin progressing towards chloride types both in the centre of the region and downstream in the Georgina River Basin; also there is a pronounced constriction along a zone between Dalmore Downs and Alexandria Homesteads of the chloride types. The distribution over the Barkly Tableland of Mesozoic rocks, Tertiary limestone deposits, and laterite indicates some warping during the Tertiary or late Mesozoic (Randal & Nichols, 1963), and it is probable that the present groundwater system attained its present configuration at about that time. However, the groundwater system may have been already in existence before that time as discussed earlier in connexion with the invasion into the system of water rich in chloride from the Mesozoic transgression.

A.J. Flavelle (BMR, pers. comm.) reports an elongated gravity minimum from south-west of Wonarah towards Alexandria Homestead with an associated gravity maximum to the west, which trends diagonally across the Alroy Sheet area from south-west to north-east. The significance of the gravity minimum in relation to the subsurface sequence is not clear, but the trend parallels anomalies in the hydraulic and geochemical parameters. R. Wells (BMR, pers. comm.) reports a similar trend in the magnetic basement. A series of closed contours indicates magnetic basement at about sea-level along a line from the Barkly Highway, about 20 miles north-west of Dalmore Downs Homestead, north-eastwards towards Alexandria Homestead.

Recommendations for future work. This study has made it obvious that a great deal of useful information has been lost because of inadequate recording of data from water bores both during and after drilling. The situation has vastly improved since the establishment of the Water Resources Branch of the Northern Territory Administration. It is essential that accurate and detailed bore-logs are kept and forwarded to the appropriate authority, and rock chips made available for geological examination. In the course of drilling some attention should be paid to the reputedly good water of the shallower aquifers even though supplies are at present not considered adequate, and some chemical analyses should be made of these waters. Chemical analyses of rock chips from the aquifers may give some help in the understanding of the chemical evolution, and subsequently in aquifer correlation, which will also be assisted by gamma ray logging. Accurate levelling of bore sites is required for the detailed study of groundwater flow. Tritium determinations and radioactive tracer studies may provide useful tools in the study of rate and direction of groundwater flow. A great deal of useful data could be obtained on pressure variations and aquifer characteristics by a series of observation wells: these will certainly be needed if the shallower aquifers are investigated.

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ADDENDA TO APPENDIX "B"

Reg.No.	Station Number	Position	Total Depth	Depth of Aquifers	Depth of standing water level	Pump Depth	Supply	Remarks
	Brunette Downs No.16	Corella Creek	-	-	-	-	-	Abandoned, replaced by R.N.3149
	" X 1	12 miles S.W. of Homestead	320	130, 210-310	103	220	3000	
	" X 2	18 " "	220	120, 180-200	106	170	2400	
	" X 3	33 " "	180	80, 165-180	104	130	2000	
	" X 4	36 " "	150	125	114		3250	
	" X 5	24 miles W. "	420	160, 260	105		1050	
	" X 6	39 " W. "	170	35, 150-165	106		3000	
	" X 7	36 " W.N.W. "	135	120-135	111		3000	
	" X 8	36 " N.W. "	150	130-150	123		3000	
	" X 9	30 " W.N.W. "	165	150-165	114		1500	
	" X 10	30 " N.W. "	245	160, 230-245	152		2000	
	" X 11	N.W. "	210	168, 200	150		3000	
	" X 12	22 " N.N.W. "	200	160, 187-200	161		3000	
	" X 13	34 " N.N.W. "	300	220, 280-300	187		2700	
	" X 14	20 " N.N.E. "	305	230, 275, 305	212		3000	
	" X 15	27 " N.E. "	270	215, 257-270	215		2700	
	" X 16	8 " S.S.W. "	450	145, 350-450	145		2000	
	" X 17	20 " S.W. "	150	103, 143-150	104		3600	
	" X 18	30 " S.S.E. "	195	132-140, 187-195	133		3600	
33	Barkly Highway No.15A	110 miles W. of Camooweal	428	-	300		360	
	Alexandria No.20A	On Gallipoli Road	-	-	-		-	Abandoned
	Rocklands No.25	-	350	300, 335-350	292		2000	Successful re-drilling of R.N.1000
	" No.31	-	-	-	-		-	
	" No.34	-	435	316, 415	292		2000	
	Alexandria No.33	-	-	-	-		-	Crooked hole - abandoned.
	No.52	-	-	-	-		-	
	No.53	Near Alexandria No.27	270	215, 235, 240	-		2400	
	No.54	" No.4	280	200, 210- 280	186		3000	
	No.55	12 miles S.W. Alexandria No.20	432	305, 410	282		2400	
	B.S.R. Quarantine		250	220, 235 -250	213		1200	Second try at R.N. 3658
623	Drought Relief	Alexandria Station	340	-	160		2400	
205	Chinaman Well	Lake Nash Station	-	-	-		-	

The above list refers to bores drilled late 1962 and 1963, or records brought to the author's attention after appendices A and B had been compiled and roneoed (early in 1963). The bores have not been visited on the ground, and since the locations given are only approximate they have not been included on the relevant maps; at present no elevations are available for them nor are any chemical analyses. However, where applicable they have been included in the statistical analyses of the bore-logs given in the text of this report under the various hydraulic parameters.

APPENDIX A.

WATER BORES - BARKLY TABLELAND

(Listed by stations and station numbers)

* Chemical analysis given in Appendices "C" and "D".

Station	Bore No.	1:250,000 Sheet area	Reg. No.	Station	Bore No.	1:250,000 Sheet area	Reg. No.
* ALEXANDRIA DOWNS	1	RANKEN	735	* ALEXANDRIA DOWNS	36	RANKEN	3126
	2	"	736		37	MOUNT DRUMMOND	3127
*	3	"	737	*	38	"	3128
*	4	"	738	*	39	"	3129
	5	AVON DOWNS	739		40	"	3130
	6	"	741	*	41	RANKEN	1148
	7	RANKEN	742		42	"	3131
	7B	AVON DOWNS	2489		43	AVON DOWNS	3132
	8	RANKEN	743	*	44	RANKEN	3133
*	9		744		45	MOUNT DRUMMOND	3134
	10	"	745	*	46	RANKEN	3135
	11	"	746	*	47	"	3136
*	12	"	747	*	48	"	3137
*	13	MT.DRUMMOND	748		49	"	2486
*	14	"	749	*	50	"	3125
	15	RANKEN	750	*	51	"	2769
*	16	"	751	* GALLIPOLI	1	"	1153
*	17	"	752	*	5	"	1155
	18	"	753		6	"	740
	19	"	754	*	7	"	1154
	New 19	"	2487	* SOUDAN H.S.		AVON DOWNS	1871
	20	"	755	* ALROY DOWNS	1	ALROY	719
*	21	"	756	*	2	"	720
	22	"	757		3	"	721
*	23	"	758	*	4	"	722
*	24	"	1150	*	5	"	723
*	25	"	1151	*	6	"	724
*	26	"	1152	*	7	"	725
	27	"	1149		8	"	726
	28	"	1144		8A	"	3142
	29	"	1143	*	9	"	727
	30	"	3124	*	10	"	728
*	31	"	1156	*	11	"	729
	32	" -	1142	*	12	"	730
	33	-	1145	*	13	"	3143
	34	AVON DOWNS	1146	*	14	"	732
	35	"	1147	*	15	"	733

	Station	Bore No.	Sheet area 1:250,000	Reg. No.
*	ALROY DOWNS	16	ALROY	3144
*		17	"	2190
*		18	"	2191
*		18A	"	3145
*		19	"	2192
*		20	"	2193
*		21	"	2194
*		22	"	2195
*		23	"	3141
*		24	"	3140
*		25	"	3139
*		26	"	3138
*	ANTHONY LAGOON	1	BRUNETTE DOWNS	604
*		2	WALHALLOW	605
*		3	"	598
*		4	"	599
*		5	"	600
*		6	"	601
*		7	BRUNETTE DOWNS	602
*		8	WALHALLOW	606
*		9	BRUNETTE DNS.	603
*		10	"	1180
*		11	"	1181
*		12	"	1182
*		13	"	1183
*		14	"	2157
*		15	WALHALLOW	2158
*		16	BRUNETTE DNS.	2159
*		17	"	2160
*		18	"	2161
*		19	"	2162
*		20	"	2163
		21	"	2164
		22	BEETALOO	2165
		23	"	-
		24	"	-
		25	WALHALLOW	3148
*		26	BRUNETTE DNS.	3147
		27	"	3146

	Station	Bore No.	1:250,000 Sheet area	Reg. No.
	AUSTRAL DOWNS +			
	Four Mile Bore		AVON DOWNS	769
	Goat Hole		"	770
	Shakespear No.1		"	771
	Shakespear No.2		"	772
	New Year Bore		"	773
	Yellow Hole No.1		"	775
	Yellow Hole No.2		"	776
	Blue-Bush		"	777
	Coolibah		"	778
	Gidyea Creek (Poison)		" "	(779 (996
	Top		"	995
	New Top		"	3662
	Goose Hole		"	1185
	Mathieson No.15		"	2140
	No.16 on Burramurra		"	2139
	No.20 Eldershaw		"	2141
	No.21		"	3178
	No.22		"	3664
	No.10 New Bore		"	3663
*	AVON DOWNS	1	AVON DOWNS	366
		2	"	346
*		3	"	340
		4	"	369
*		5	RANKEN	83
*		6	"	84
	(17 mile well)	7	AVON DOWNS	214
		8	RANKEN	347
		9	"	352
*		10	"	392
*		11	"	951
		(Old No.12	"	359
*		12	"	3159
		13	AVON DOWNS	318
*		14	"	331
		(Old No.15	"	91
		15	"	3160
		16	"	93
*	(Burramurra)	17 +	"	92
	"	18 +	"	94
	"	19 +	"	95
*		20	RANKEN	96
		21	"	97

+ Bore Nos.17, 18, and 19 on the Burramurra Block were put down by Avon Downs Station but have since been transferred to Austral Downs Station.

	Station	Bore No.	1:250,000 Sheet area	Reg. No.
*	AVON DOWNS	22	AVON DOWNS	98
*		23	"	384
*		24	"	994
		25	"	3161
*		26	RANKEN	3162
	BRUNETTE DOWNS	1	BRUNETTE DNS.	933
*	Corella	No. 2	"	934
*	Rocky	No.2	ALROY	1212
*		3	BRUNETTE DNS.	935
		4	"	936
		5	"	937
	Old	6	"	938
*	New	6	"	795
		7	"	760
*		8	"	761
*		9	"	762
		10	"	763
		11	"	764
		12	"	765
		13	"	766
	Old	14	"	767
*		14	"	1211
		15	"	768
*		16	"	3149
*		17	"	1225
*		18	"	360
*		19	"	1227
		20	NOW ANTHONY LAGOON	No.8
		21	BRUNETTE DNS.	354
*		22	"	112
		23	"	243
*		24	ALROY	403
*		25	BRUNETTE DNS.	115
*		26	"	116
*		27	"	117
*		28	"	118
*		29	"	119
		30	"	120
		31	"	121
		32	"	122
*		33	"	123
*	BRUNETTE DOWNS	34	ALROY	124
		35	BRUNETTE DNS.	299
		36	"	336
*		37	"	1213
*		38	"	1214
*		39	"	1215
*		40	"	1216
*		41	*	1217
*		42	"	1218
*		43	"	1219
*		44	"	1220
*		45	"	1221
*		46	"	1222
*		47	"	1223
*		48	"	1228
*		49	"	1229
*		50	"	1230
*		51	"	3118
		52	"	3117
*		53	"	3116
*		54	"	3115
*		55	"	3114
*		56	"	3113
*		57	"	3112
*		58	"	3111
*		59	"	3110
*		60	"	3109
*		K1	"	3100
*		K2	"	3101
*		K3	"	3102
*		K4	"	3103
*		K5	"	3104
*		K6	"	3105
		K7	ALROY	3106
*		K8	BRUNETTE DNS.	3107
*		K9	ALROY	3108
	(1st.)	D1	"	3120
*		D1	"	2579
*		D2	BRUNETTE DNS.	1990
		D3	"	1991
		D4	"	1992
*		D5	"	1993

	Station	Bore No.	1:250,000 Sheet area	Reg. No.
	BRUNETTE DOWNS.	D6	BRUNETTE DNS.	1994
*		D7	"	2758
*		D8	"	1995
*		D9	"	1996
	(1st.hole	D10	"	2279
*		D10	"	2280
*		D11	ALROY	2281
*		D12	BRUNETTE DNS.	2282
*		D13	"	2283
*		D14	"	1998
*		D15	"	3119
*		D16	ALROY	3123
*		D17	BRUNETTE DNS.	3122
		D18	"	3121
*		D19	"	2287
*		D20	"	2288
*		D21	"	2289
*		D22	"	2498
*		D23	"	2499
*		D24	"	2500
*		D25	"	2501
*		D26	"	2502
*		D27	"	2503
*		D28	"	2504
*		D29	"	2505
*		D30	"	2506
*		D31	"	2507
		D32	"	2508
		D33	"	2584
*		D34	"	2585
*		D35	"	2586
*		D36		2577
*		D37	"	2578
*		D38	"	2583
*		D39	"	2580
*		D40	"	2581
*		D41	"	2582
		D42	"	
		D43	"	3654
*		D44	"	3655
*		D45	"	3656
*		D46	"	3568

	Station	Bore No.	1:250,000 Sheet area	Reg. No.
	RACE COURSE BORE		BRUNETTE DNS.	2757
*	SCHOOL HOUSE	"	"	1757
*	CRESWELL DOWNS	1	WALHALLOW	1246
*		2	"	1247
*		3	"	1248
*		4	"	1249
*		5	BRUNETTE DNS.	1250
*		6	WALHALLOW	1251
*		7	"	1252
*		8	"	2413
*		9	BRUNETTE DNS.	2412
*		10	WALHALLOW	2411
*		11	"	2410
*		12	"	2409
		Dud	BRUNETTE DNS.	2744
*		13	"	2745
*		14	WALHALLOW	2746
		Dud	CALVERT HILLS	2747
		15	"	2748
		16	WALHALLOW	2749
		17	"	2750
*		18	"	2751
*	Kelly		"	2752
*	Collabirrian (Walhallow No.2)		"	960
*	Coolibah		"	1070
	Walhallow	1	"	952
		3	"	961
	DALMORE DOWNS			
*		1	ALROY	1236
*		2	"	1237
		3	"	1238
*		4	"	1239
*		5	"	1240
*		6	"	1241
*		7	"	1242
*	No.8 (18A Barkly Hwy.)		"	353
*	No.9 (14A " ")		"	29
	No.10(9A " ")		"	43
		11	"	1749
		12	"	3659
*		13	"	731
		14	"	3660
		15	"	3661

	Station	Bore No.	1:250,000 Sheet area	Reg. No.
	LAKE NASH	22	AVON DOWNS	75
	MALLAPUNYAH			
*	Bullock Ck.Bore		WAITHALLOW	1067
	ROCKHAMPTON DOWNS			
*		1	BRUNETTE DNS.	2222
*		2	"	2223
*		3	ALROY	358
*		4	"	395
*		5	BRUNETTE DNS.	415
*		6	ALROY	396
*		7	"	285
		8	HELEN SPRINGS	140
*		9	BRUNETTE DNS.	413
*		10	"	398
*		11	"	394
*		12	"	405
*		13	"	317
*		14	ALROY	414
		15	HELEN SPRINGS	237
		16	"	
*		17	BRUNETTE DNS.	2224
*		18	"	2225
*		19	"	2226
*		20	"	2227
*		21	"	2228
*		22	ALROY	2229
		23	TENNANT CK.	2230
		24	"	2231
*		25	BRUNETTE DNS.	2232
*		26	"	2233
*		27	"	2234
*		28	"	2235
*		29	ALROY	2236
*		30	"	2940
		31	"	2941
*		32	"	2942
		33	BRUNETTE DNS.	2958
	ROCKLANDS	1	CAMOOWEAL	-
		2	"	-
		3	"	-
		4	MOUNT ISA	-
		5	AVON DOWNS	939
		6	RANKEN	940

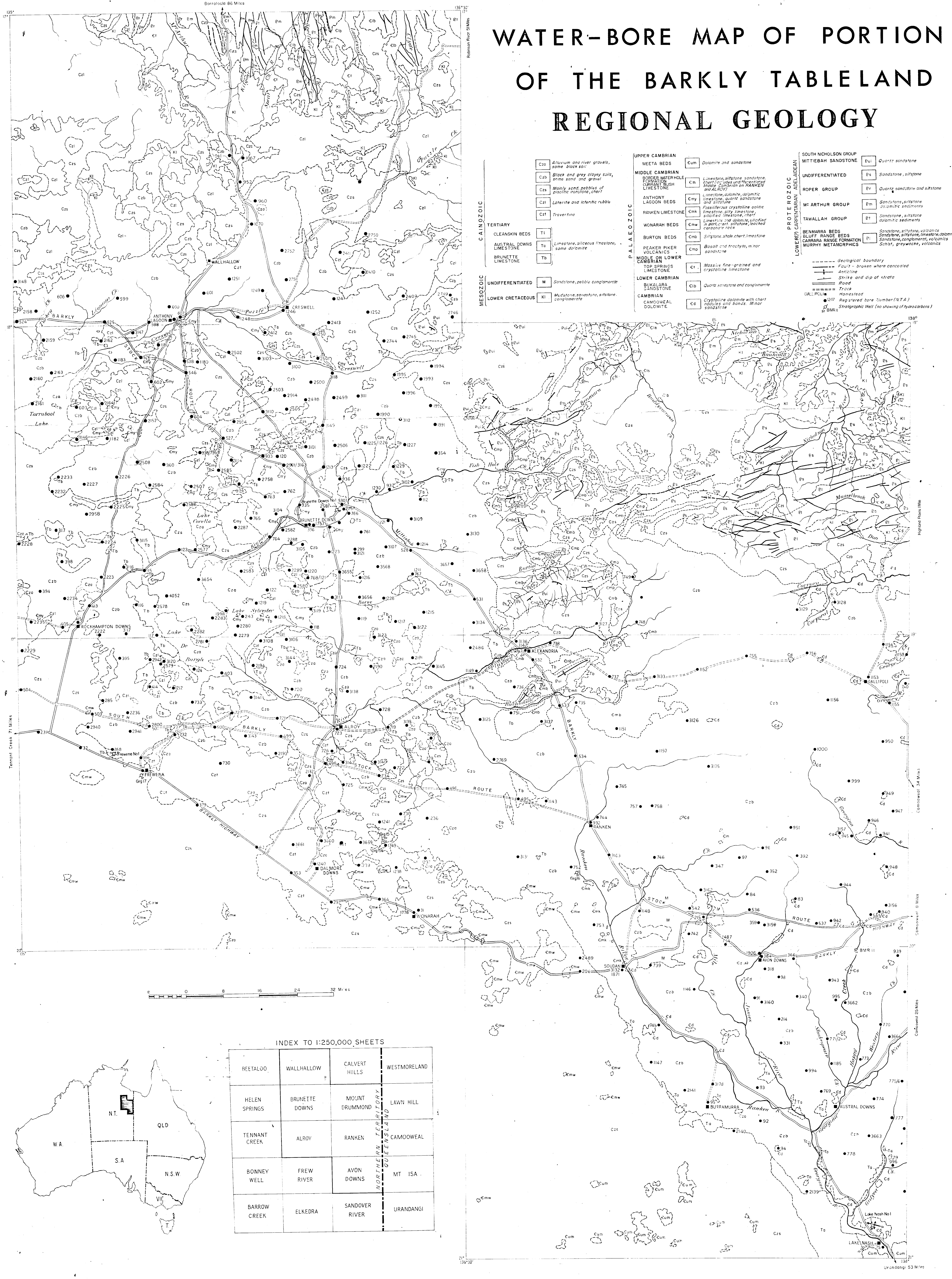
	Station	Bore No.	1:250,000 Sheet Area	Reg. No.
	ROCKLANDS	7	MOUNT ISA	-
		8	CAMOOWEAL	-
		9	"	-
*		10	RANKEN	941
		11	"	942
		12	AVON DOWNS	943
*		13	RANKEN	944
		14	"	945
		15	"	946
		16	"	947
		17	"	948
		18	CAMOOWEAL	-
*		19	RANKEN	949
		20	CAMOOWEAL	-
		21	"	-
		22	"	-
		23	RANKEN	950
		24	"	999
		25	"	1000
		26	CAMOOWEAL	-
*		27	RANKEN	3156
*		28	"	3157
	Herbert Vale	4	"	3158
		29	CAMOOWEAL	-
	BARKLY STOCK ROUTE			
*		1	WAITHALLOW	525
*		2	"	524
	Desert		BRUNETTE DNS.	526
*	Wendy		"	546
*	Boundary		"	527
*	Bishop		"	2901
	Bishop (old bore)		"	3163
* *	Brunette		"	530
*	Mittiebah		"	528
*	Connells		MT.DRUMMOND	531
	Alexandria		RANKEN	532
*	Buchanan		"	533
	Ranken Plain		"	534
*	Ranken		"	932
*	Wilfred		"	3163
*	O'Reilly		"	542
*	Avon		"	536
*	Rocklands W.		"	537
*	Rocklands E.		"	545

	Station	Bore No.	1:250,000 Sheet area	Reg. No.	Station	Bore No.	1:250,000 Sheet Area	Reg. No.
	NEW QUARANTINE		MT. DRUMMOND	3658				
	Quarantine		Brunette Dns.	3657				
	SOUTH BARKLY STOCK ROUTE							
*		1	RANKEN	495				
		2.	ALROY	496				
*		3	"	734				
		4	"	498				
		5	"	499				
*		6	"	500				
		(Old)7	"	501				
*		7	"	2800				
*		8	"	503				
*		9	"	504				
	BARKLY HIGHWAY BORES							
		4A	ALROY	31				
		17A	"	32				
*	(Frewena)	6A	"	41				
		21A	"	231				
*		18A	"	353				
		16A	"	364				
		11A	"	379				
*		14A	"	29				
		9A	"	43				
		22A	RANKEN	215				
		7A	AVON DOWNS	206				
	MISCELLANEOUS GOVERNMENT BORES							
	Anthony Lagoon Police		WALLHALLOW	607				
	Anthony Old Dip		BRUNETTE DNS.	538				
*	Avon Downs Police		AVON DOWNS	1906				
	Nemo Bore		BRUNETTE DNS.	2914				
*	Wonarah		ALROY	-				

PLATE I

WATER-BORE MAP OF PORTION OF THE BARKLY TABLELAND

REGIONAL GEOLOGY



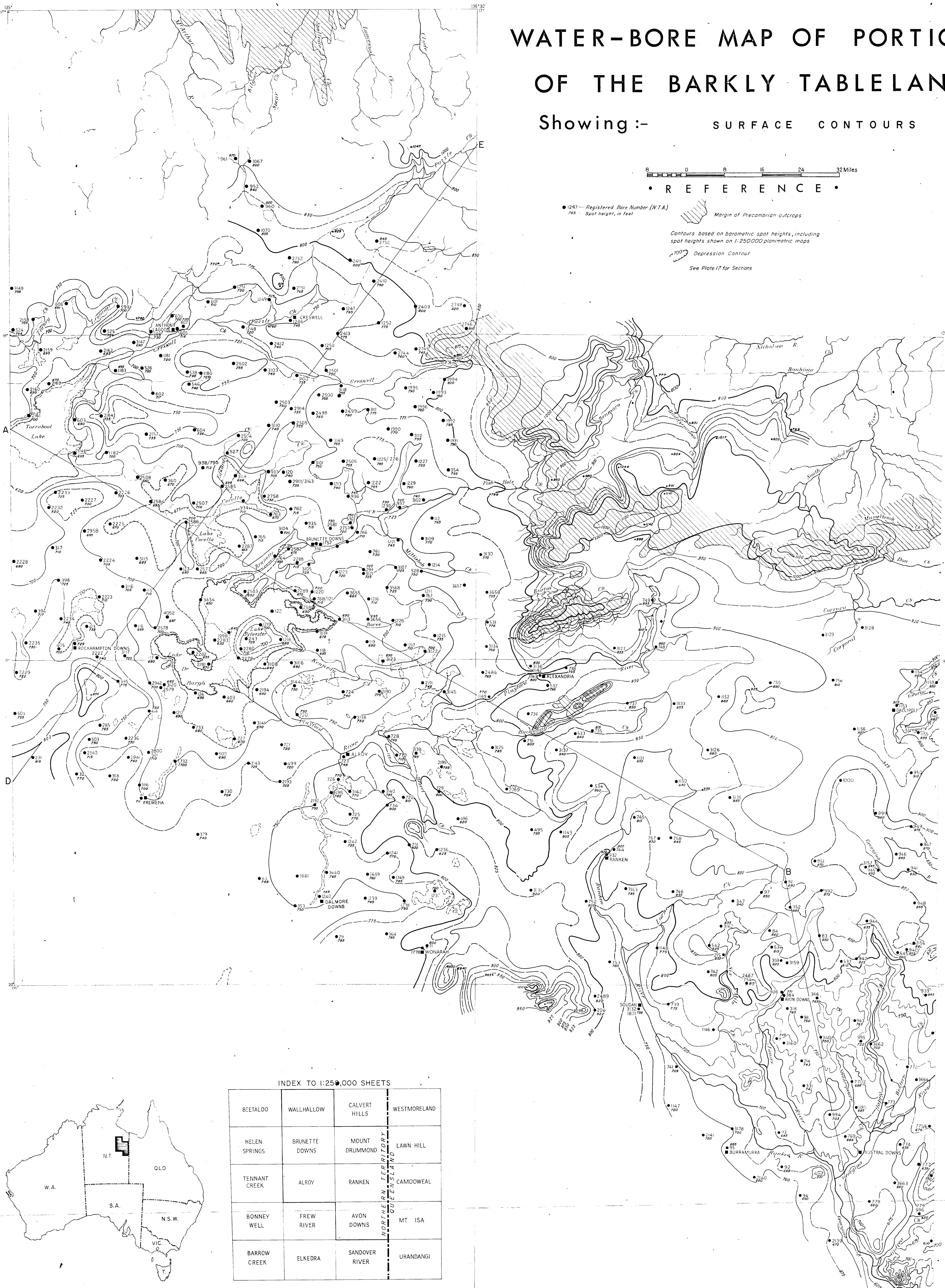
Bureau of Mineral Resources, Geology & Geophysics. September 1963 & May 1965

To accompany Record No 1966/11

NT/A/113 G.M.

WATER-BORE MAP OF PORTION OF THE BARKLY TABLELAND

Showing :- SURFACE CONTOURS



• REFERENCE •

● 1247 — Registered Bore Number (N.T.A.)
765 - Spot height, in feet

Margin of Precambrian outcrops

Contours based on barometric spot heights, including spot heights shown on 1:250000 planimetric maps

700 Depression Contour

See Plate 17 for Sections

INDEX TO 1:250,000 SHEETS

BEETALOO	WALLHALLOW	CALVERT HILLS	WESTMORELAND
HELEN SPRINGS	BRUNETTE DOWNS	MOUNT DRUMMOND	LAWN HILL
TENNANT CREEK	ALROY	RANKEN	CAMOOWEAL
BONNEY WELL	FREW RIVER	AVON DOWNS	MT ISA
BARROW CREEK	ELKEDRA	SANDOVER RIVER	URANDANGI

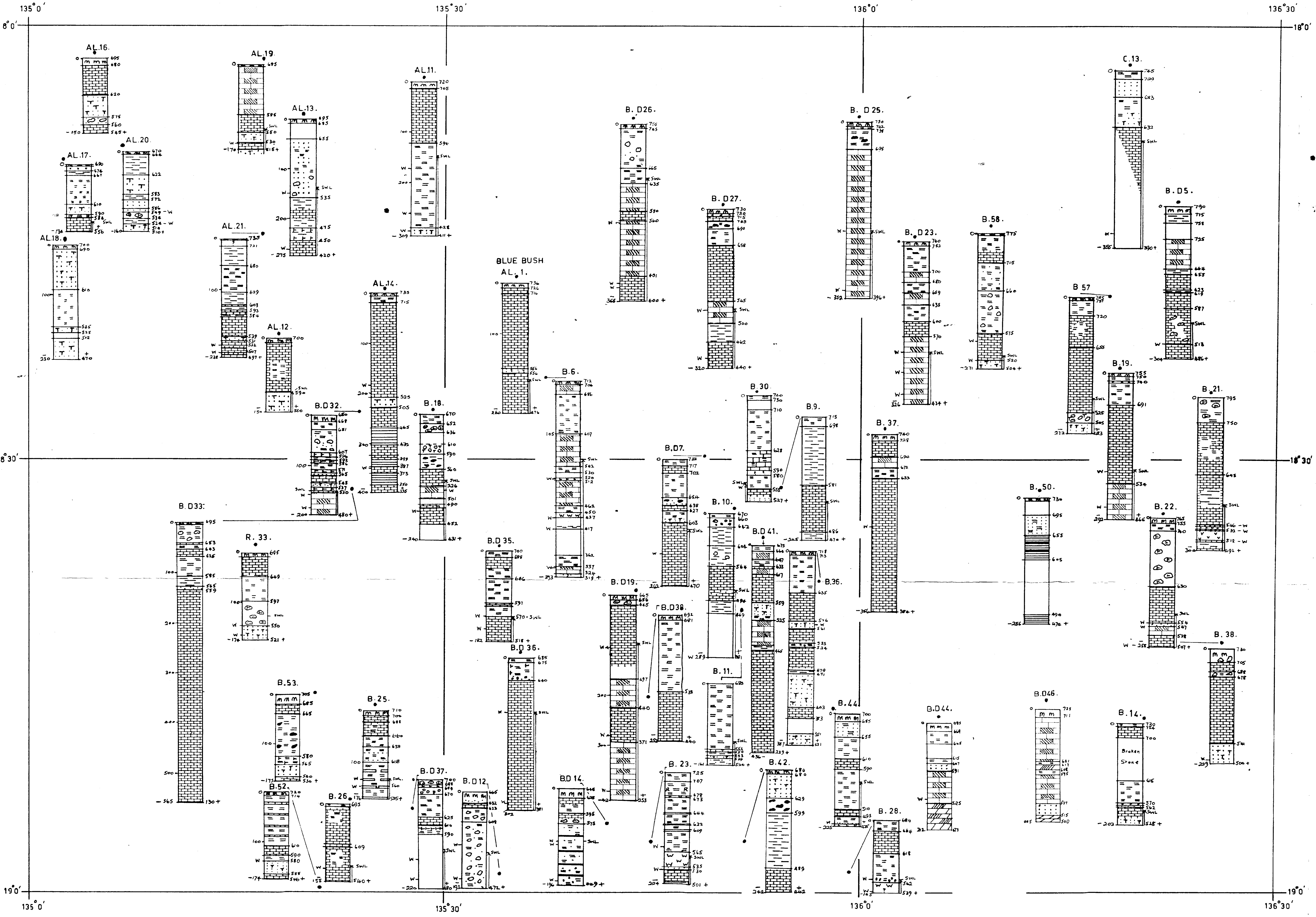
NORTHERN TERRITORY
QUEENSLAND

Bureau of Mineral Resources, Geology & Geophysics. September 1963 & May 1965

To accompany Record No 1966/11

PLATE 3a

INTERPRETATION OF DRILLER'S LOGS IN THE BRUNETTE DOWNS SHEET AREA



KEY

- ● SUB ARTESIAN BORE.
- AL ANTHONY LAGOON.
- B BRUNETTE DOWNS
- C CRESWELL DOWNS.
- R ROCKHAMPTON DOWNS.
- B.D1 etc BRUNETTE DOWNS WATER BORE No.D1.
- W LEVEL OF AQUIFER.
- SWL STANDING WATER LEVEL.
- 300'+ FIGURES ON RIGHT REFER HEIGHT ABOVE SEA LEVEL.
- -300' FIGURES ON LEFT REFER TO DEPTH BELOW COLLAR.

- m SOIL.
- CLAY: VAR. COLOURS
- SHALE.
- SAND, & SANDSTONE (T).
- GRAVEL & BOULDERS; CONGLOMERATE (T)
- CHERT BOULDERS & BANDS.
- LIMESTONE & LIMESTONE BOULDERS, VARIOUS COLOURS.
- RIBBONSTONE, LIMESTONE & CHERT NODULES
- VOLCANIC ROCK.
- SLATE.
- W WATER STONE.
- DOLOMITE & CHERT.

N

0 5 10
MILES

100 ft.
50
0

Bureau of Mineral Resources, Geology and Geophysics

To accompany Record No 1963/72 & 1966/11

E 53/15/1

INTERPRETATION OF DRILLERS LOGS IN THE ALROY SHEET AREA.

To accompany Record No 1963/72 & 1966/11

INTERPRETATION OF DRILLER'S LOGS IN THE RANKEN SHEET AREA.

Plate 3c

Bureau of Mineral Resources, Geology and Geophysics April 1962

To accompany Record 1962/55, 61 & 1966/11

E 53/16/3

Plate 5 d

INTERPRETATION OF DRILLER'S LOGS IN THE AVON DOWNS SHEET AREA.

Bureau of Mineral Resources, Geology and Geophysics. April 1962

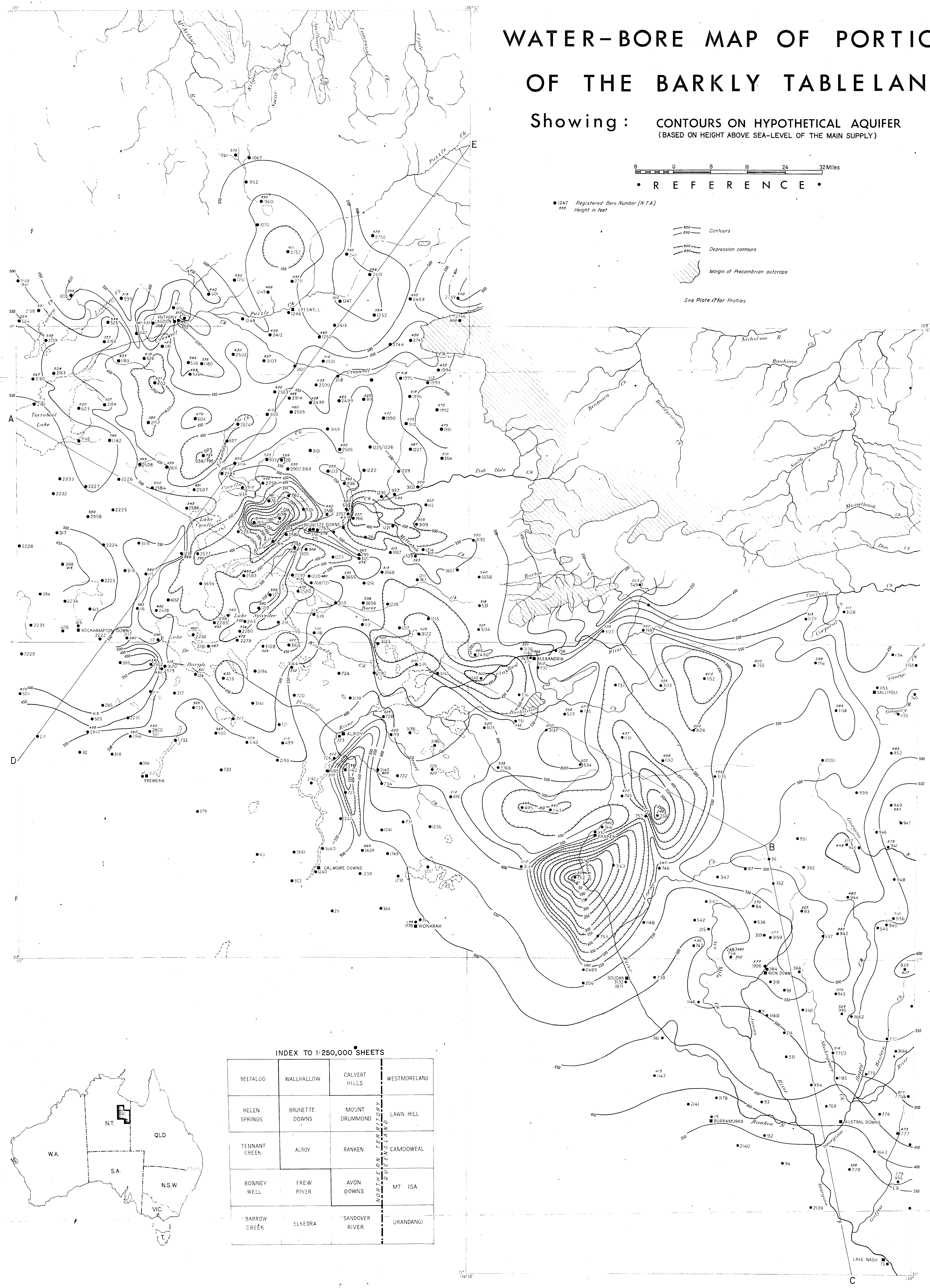
To accompany Record 1962/56 & 61 & 1966/11

F 53/4/2

WATER-BORE MAP OF PORTION OF THE BARKLY TABLELAND

Showing: CONTOURS ON HYPOTHETICAL AQUIFER

(BASED ON HEIGHT ABOVE SEA-LEVEL OF THE MAIN SUPPLY)



Bureau of Mineral Resources, Geology & Geophysics September, 1963 and May 1965

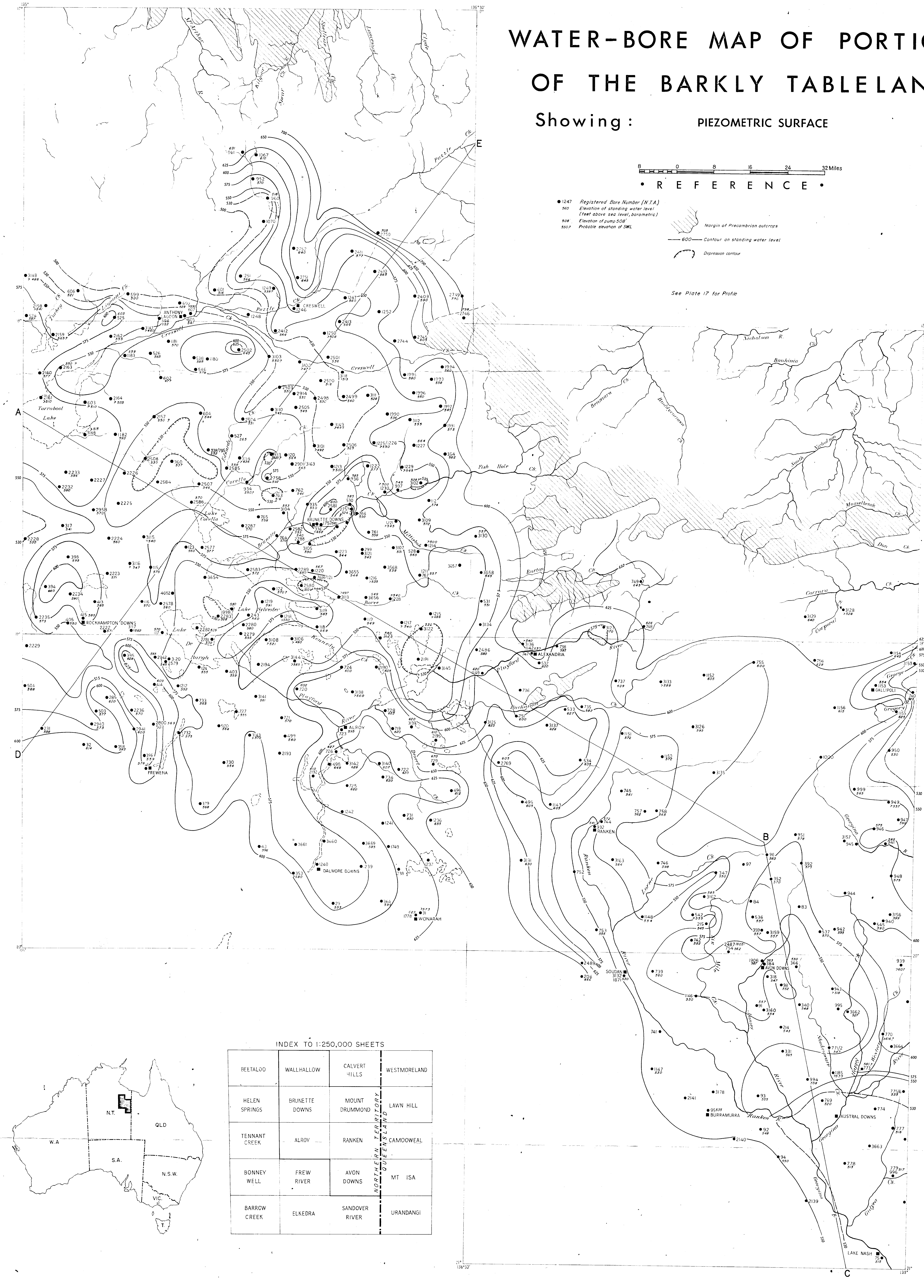
To accompany Record N° 1965/11

G.M.

Plate 5

WATER-BORE MAP OF PORTION OF THE BARKLY TABLELAND

Showing: PIEZOMETRIC SURFACE



• R E F E R E N C E •

- ● 1247 Registered Bore Number (N.T.A.)
- 560 Elevation of standing water level (feet above sea level, barometric)
- 508′ Elevation of pump 508′
- 550? Probable elevation of SWL
- Margin of Precambrian outcrops
- —600— Contour on standing water level
- Depression contour

See Plate 17 for Profile

INDEX TO 1:250,000 SHEETS

BEETALOO	WALLHALLOW	CALVERT HILLS	WESTMORELAND
HELEN SPRINGS	BRUNETTE DOWNS	MOUNT DRUMMOND	LAWN HILL
TENNANT CREEK	ALROY	RANKEN	CAMOOWEAL
BONNEY WELL	FREW RIVER	AVON DOWNS	MT ISA
BARROW CREEK	ELKEDRA	SANDOVER RIVER	URANDANGI

NORTHERN TERRITORY
QUEENSLAND

Bureau of Mineral Resources, Geology & Geophysics, September 1963 and May 1965

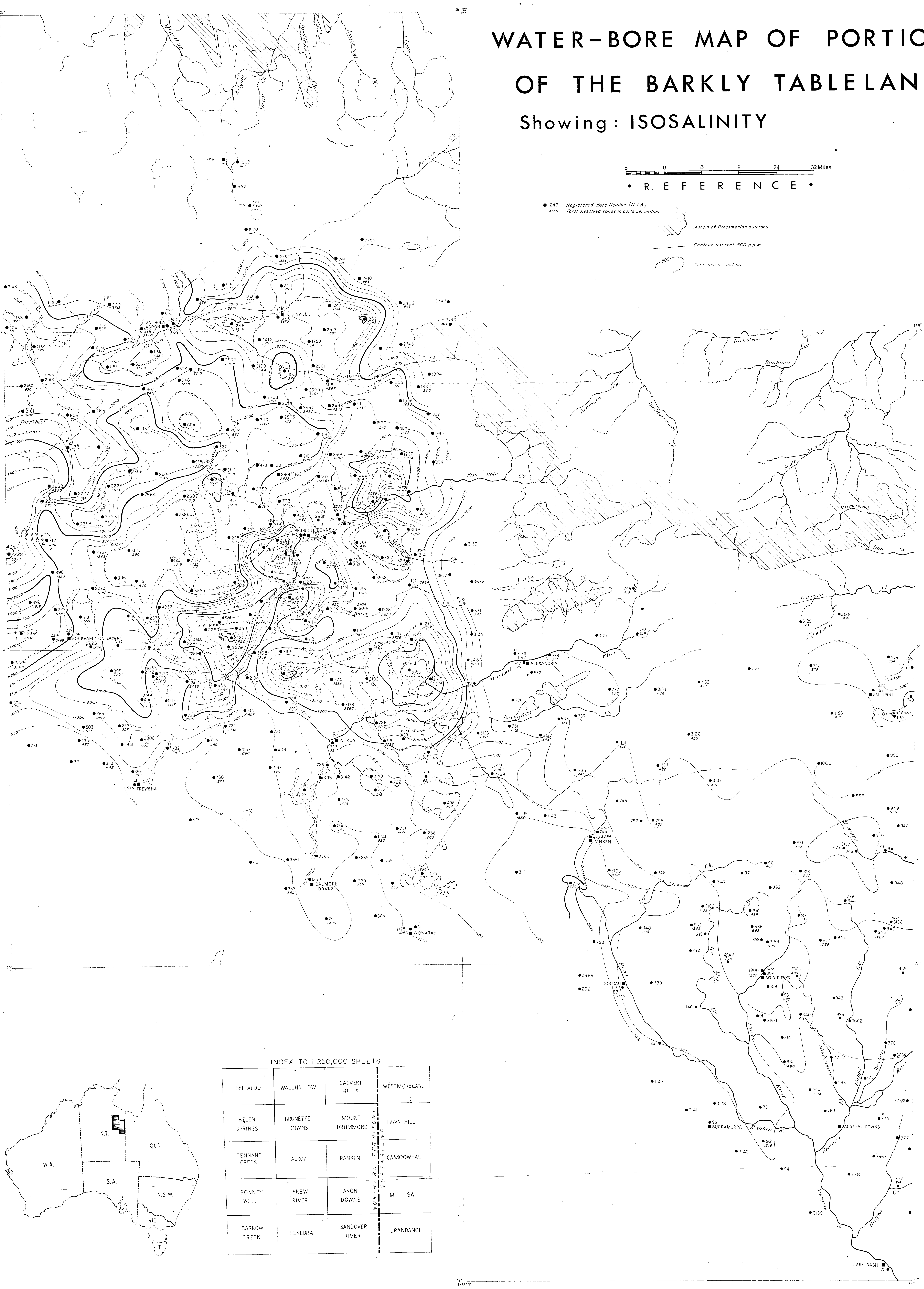
To accompany Record Nº 1966/11

NT/A/46 G.M.

Plate 6

WATER-BORE MAP OF PORTION OF THE BARKLY TABLELAND

Showing: ISOSALINITY



INDEX TO 1:250,000 SHEETS

BEETALOO	WALLHALLOW	CALVERT HILLS	WESTMORELAND
HELEN SPRINGS	BRUNETTE DOWNS	MOUNT DRUMMOND	LAWN HILL
TENNANT CREEK	ALROY	RANKEN	CAMOOWEAL
BONNEY WELL	FREW RIVER	AVON DOWNS	MT ISA
BARROW CREEK	ELKEDRA	SANDOVER RIVER	URANDANGI

NORTHERN TERRITORY | QUEENSLAND

NT/A/45

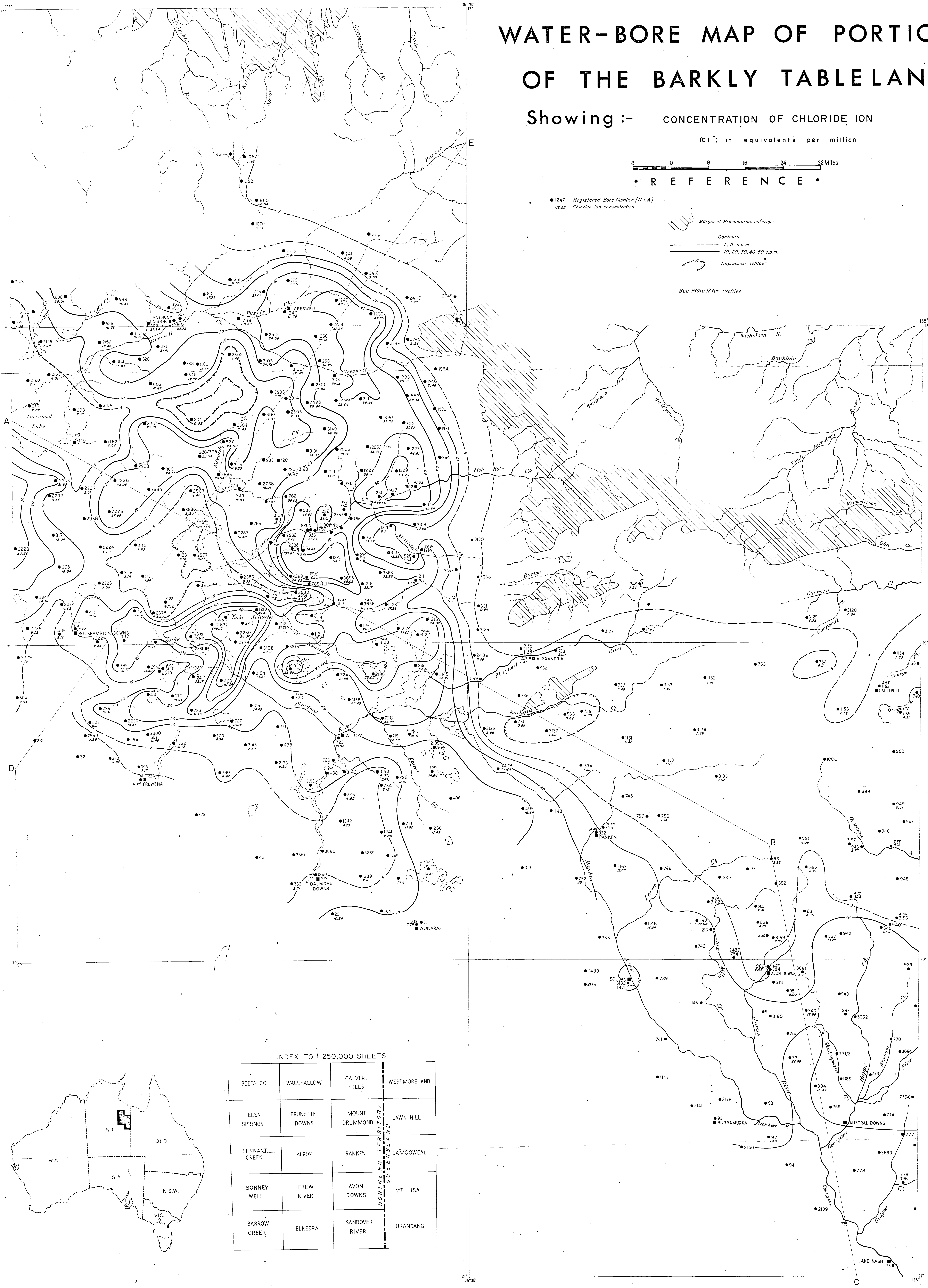
Bureau of Mineral Resources. Geology & Geophysics. September 1963 & May 1965

To accompany Record Nº 1966/11

WATER-BORE MAP OF PORTION OF THE BARKLY TABLELAND

Showing :- CONCENTRATION OF CHLORIDE ION

(Cl⁻) in equivalents per million



INDEX TO 1:250,000 SHEETS

BEETALOO	WALLHALLOW	CALVERT HILLS	WESTMORELAND
HELEN SPRINGS	BRUNETTE DOWNS	MOUNT DRUMMOND	LAWN HILL
TENNANT CREEK	ALROY	RANKEN	CAMOOWEAL
BONNEY WELL	FREW RIVER	AVON DOWNS	MT ISA
BARROW CREEK	ELKEDRA	SANDOVER RIVER	URANDANGI

NORTHERN TERRITORY QUEENSLAND

Bureau of Mineral Resources. Geology & Geophysics. September 1963 & May 1965

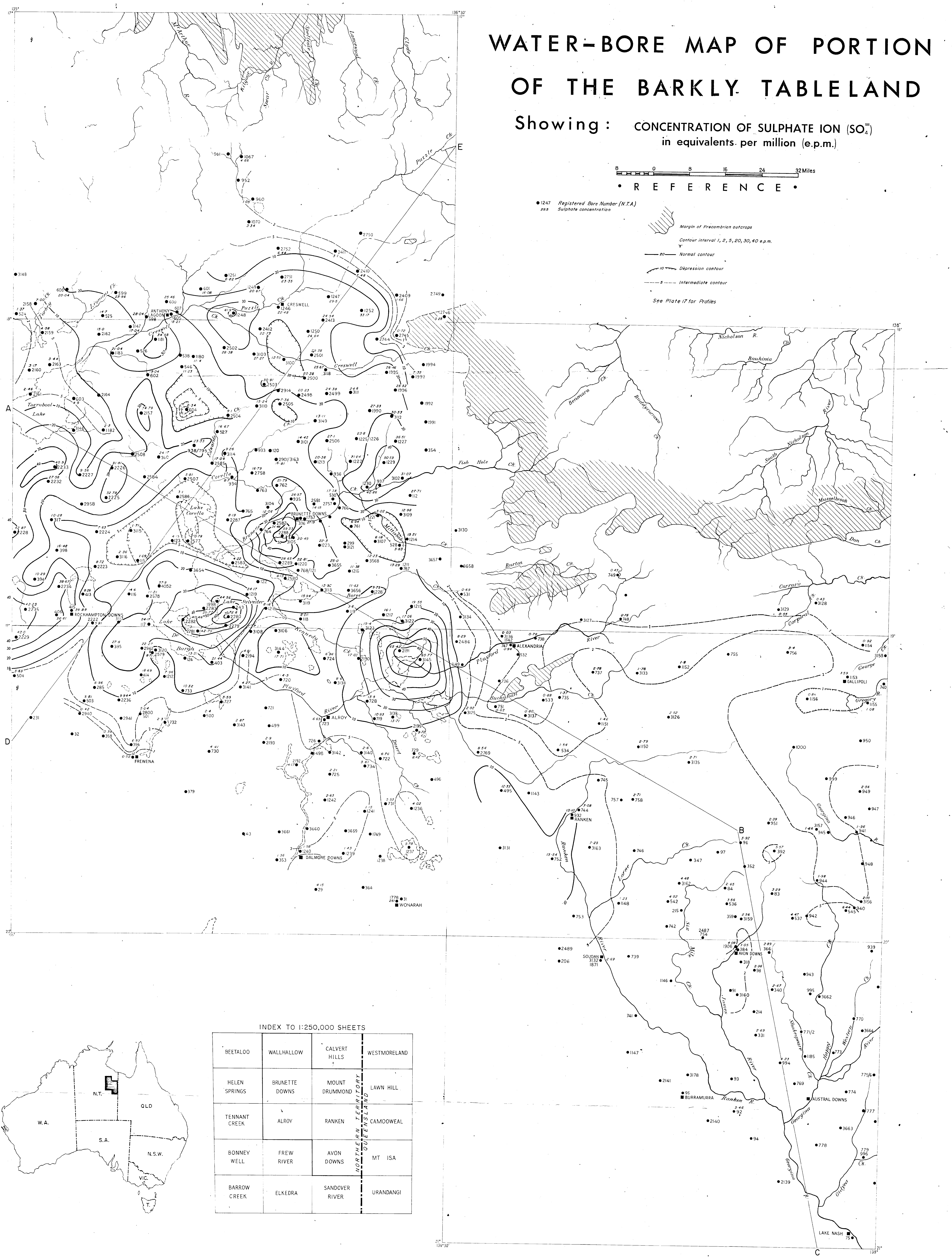
To accompany Record Nº 1965/11

NT/A/48 G.M.

Plate 8

WATER-BORE MAP OF PORTION OF THE BARKLY TABLELAND

Showing: CONCENTRATION OF SULPHATE ION ($SO_4^{=}$) in equivalents per million (e.p.m.)



INDEX TO 1:250,000 SHEETS

BEETALOO	WALLHALLOW	CALVERT HILLS	WESTMORELAND
HELEN SPRINGS	BRUNETTE DOWNS	MOUNT DRUMMOND	LAWN HILL
TENNANT CREEK	ALROY	RANKEN	CAMOOWEAL
BONNEY WELL	FREW RIVER	AVON DOWNS	MT ISA
BARROW CREEK	ELKEDRA	SANDOVER RIVER	URANDANGI

NORTHERN TERRITORY
QUEENSLAND

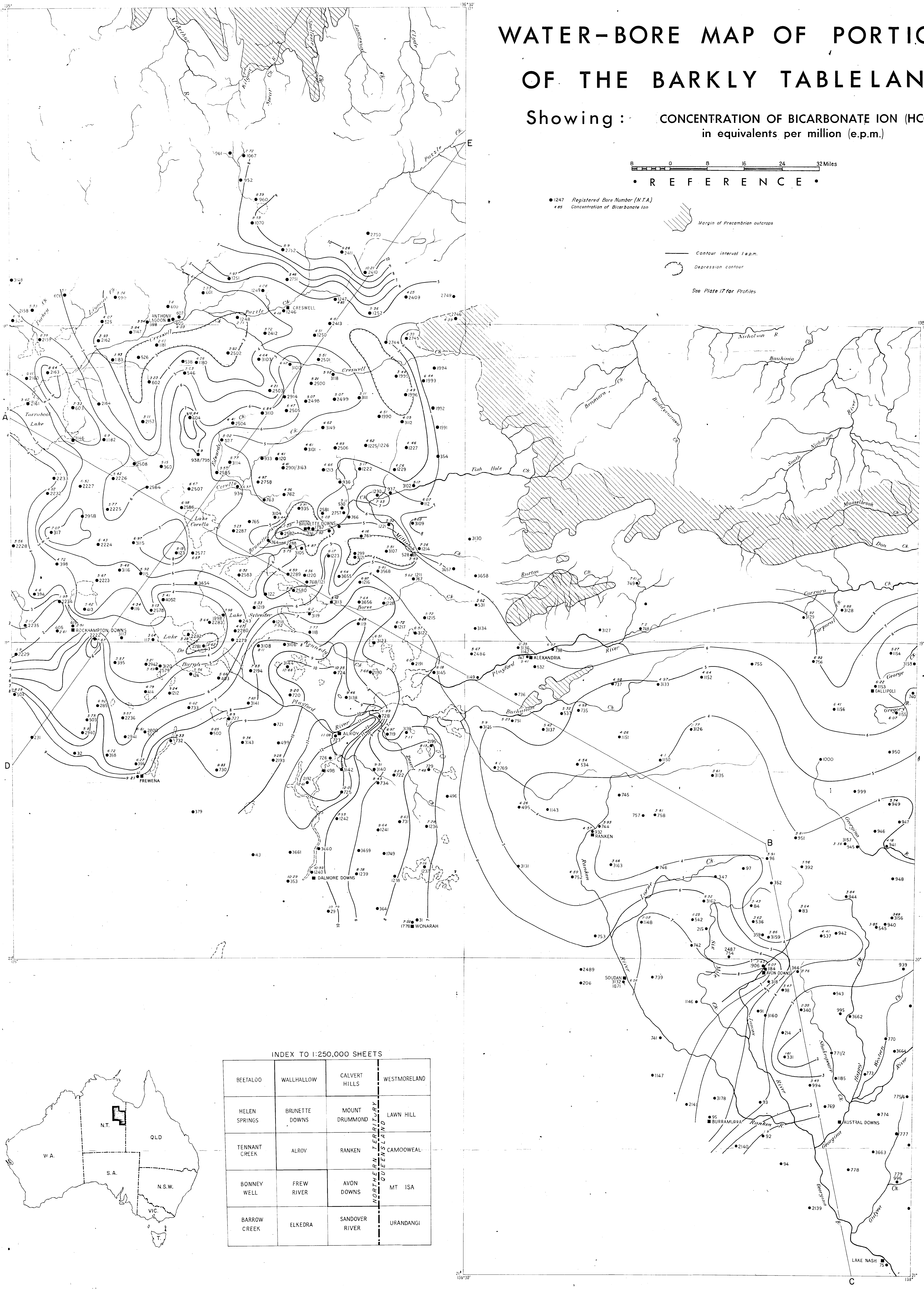
Bureau of Mineral Resources Geology & Geophysics September 1963 & May 1965

To accompany Record Nº 1966/11

NT/A/41 G.M.

WATER–BORE MAP OF PORTION OF THE BARKLY TABLELAND

Showing: CONCENTRATION OF BICARBONATE ION (HCO_3^-) in equivalents per million (e.p.m.)



INDEX TO 1:250,000 SHEETS

BEETALOO	WALLHALLOW	CALVERT HILLS	WESTMORELAND
HELEN SPRINGS	BRUNETTE DOWNS	MOUNT DRUMMOND	LAWN HILL
TENNANT CREEK	ALROY	RANKEN	CAMOOWEAL
BONNEY WELL	FREW RIVER	AVON DOWNS	MT ISA
BARROW CREEK	ELKEDRA	SANDOVER RIVER	URANDANGI

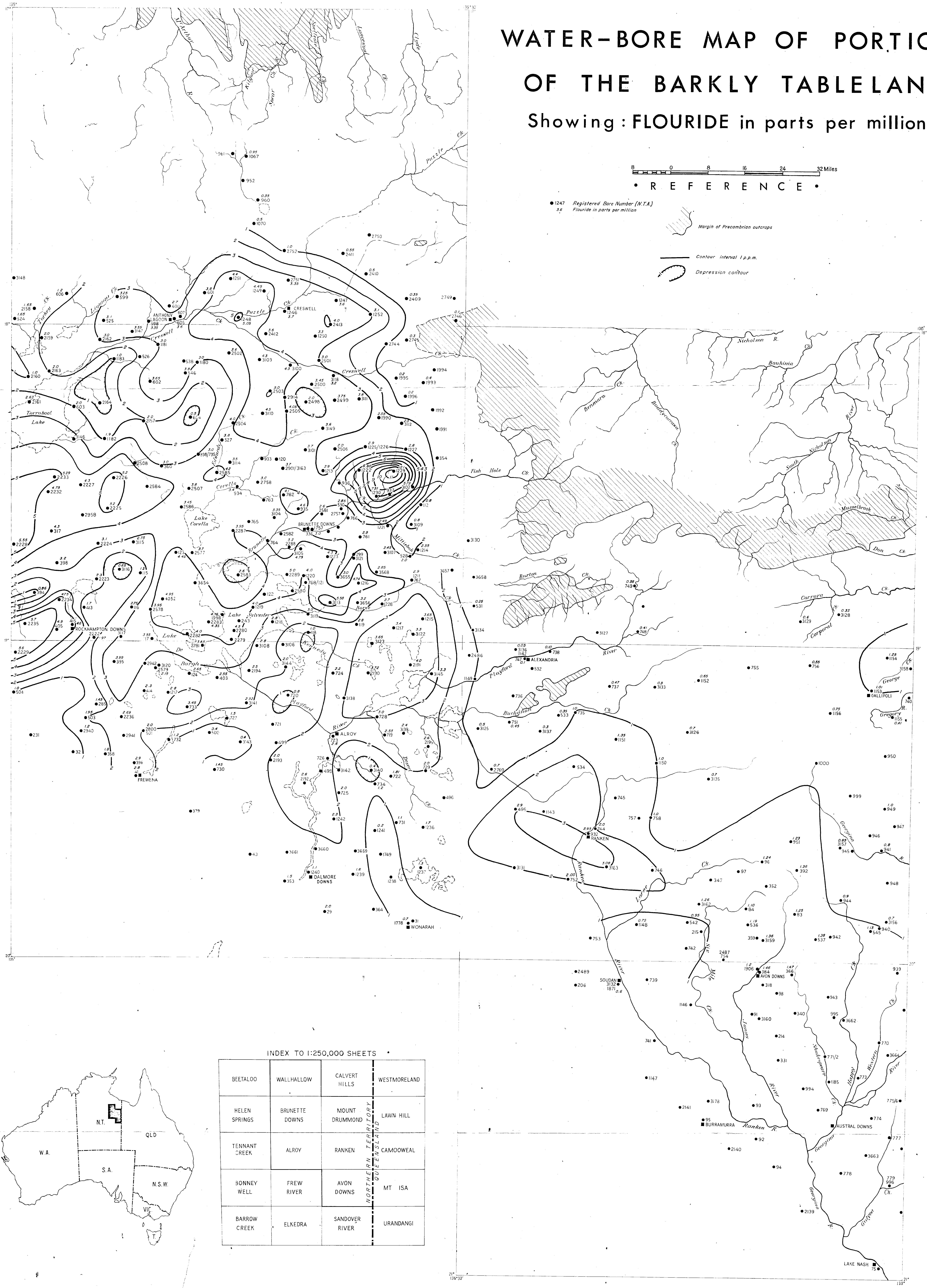
Bureau of Mineral Resources, Geology & Geophysics. September 1963 & May 1965.

To accompany Record No 1966/11

Plate 10

WATER-BORE MAP OF PORTION OF THE BARKLY TABLELAND

Showing : **FLOURIDE** in parts per million



INDEX TO 1:250,000 SHEETS

BEETALOO	WALLHALLOW	CALVERT HILLS	WESTMORELAND
HELEN SPRINGS	BRUNETTE DOWNS	MOUNT DRUMMOND	LAWN HILL
TENNANT CREEK	ALROY	RANKEN	CAMOOWEAL
BONNEY WELL	FREW RIVER	AVON DOWNS	MT ISA
BARROW CREEK	ELKEDRA	SANDOVER RIVER	URANDANGI

NORTHERN TERRITORY
QUEENSLAND

Bureau of Mineral Resources, Geology & Geophysics. September 1963 & May 1965.

To accompany Record Nº 1966/11

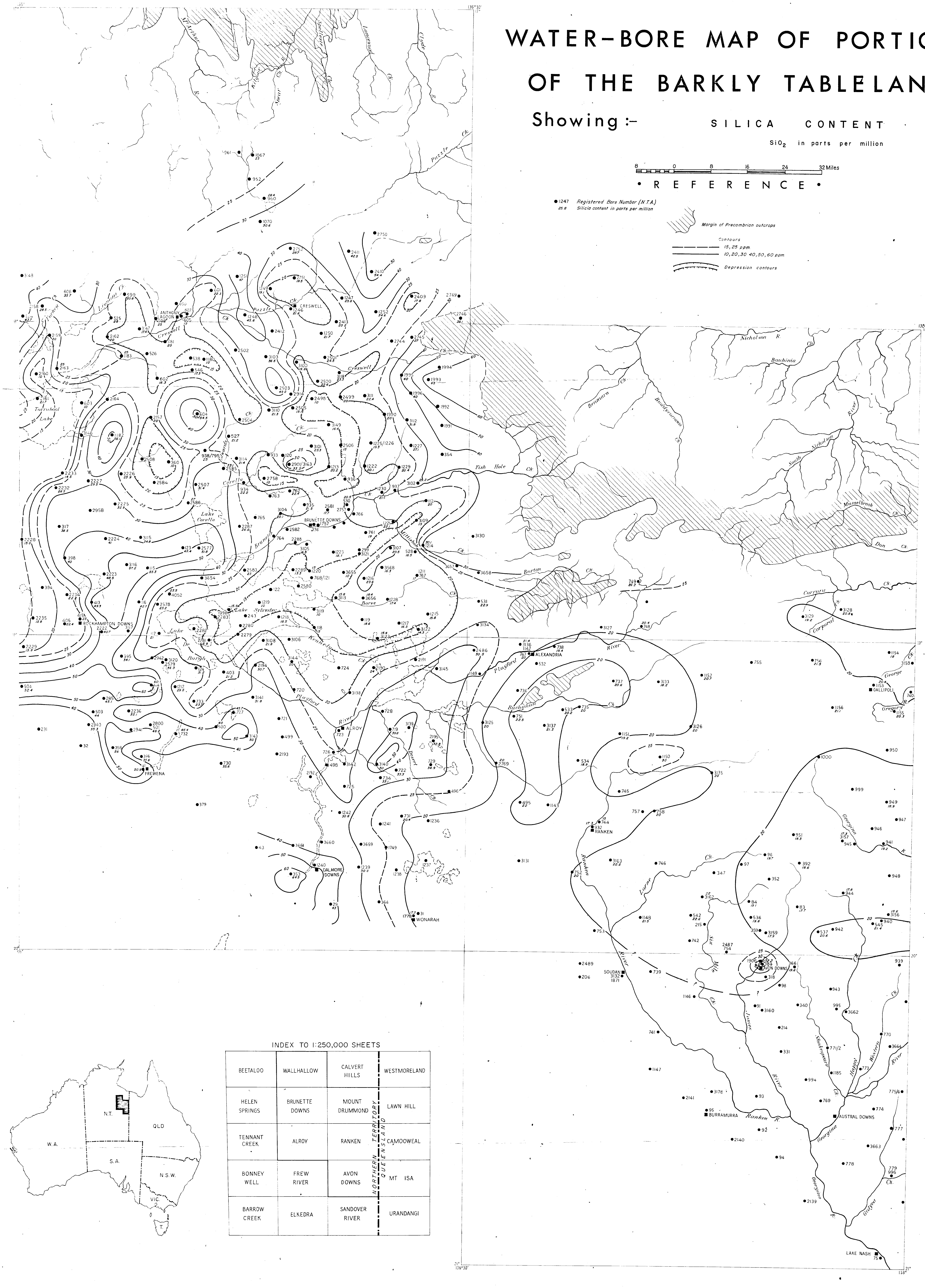
NT/A/50 G.M.

Plate II

WATER-BORE MAP OF PORTION OF THE BARKLY TABLELAND

Showing :- SILICA CONTENT

SiO_2 in parts per million



• R E F E R E N C E •

- ● 1247 *Registered Bore Number (N.T.A.)*
- 25.8 *Silicia content in parts per million*
- ▨ *Margin of Precambrian outcrops*

Contours

- – – – – *15, 25 p.p.m.*
- ——— *10, 20, 30 40, 50, 60 p.p.m.*
- *Depression contours*

INDEX TO 1:250,000 SHEETS

BEETALOO	WALLHALLOW	CALVERT HILLS	WESTMORELAND
HELEN SPRINGS	BRUNETTE DOWNS	MOUNT DRUMMOND	LAWN HILL
TENNANT CREEK	ALROY	RANKEN	CAMOOWEAL
BONNEY WELL	FREW RIVER	AVON DOWNS	MT ISA
BARROW CREEK	ELKEDRA	SANDOVER RIVER	URANDANGI

NORTHERN TERRITORY
QUEENSLAND

Bureau of Mineral Resources. Geology & Geophysics. September 1963 & May 1965

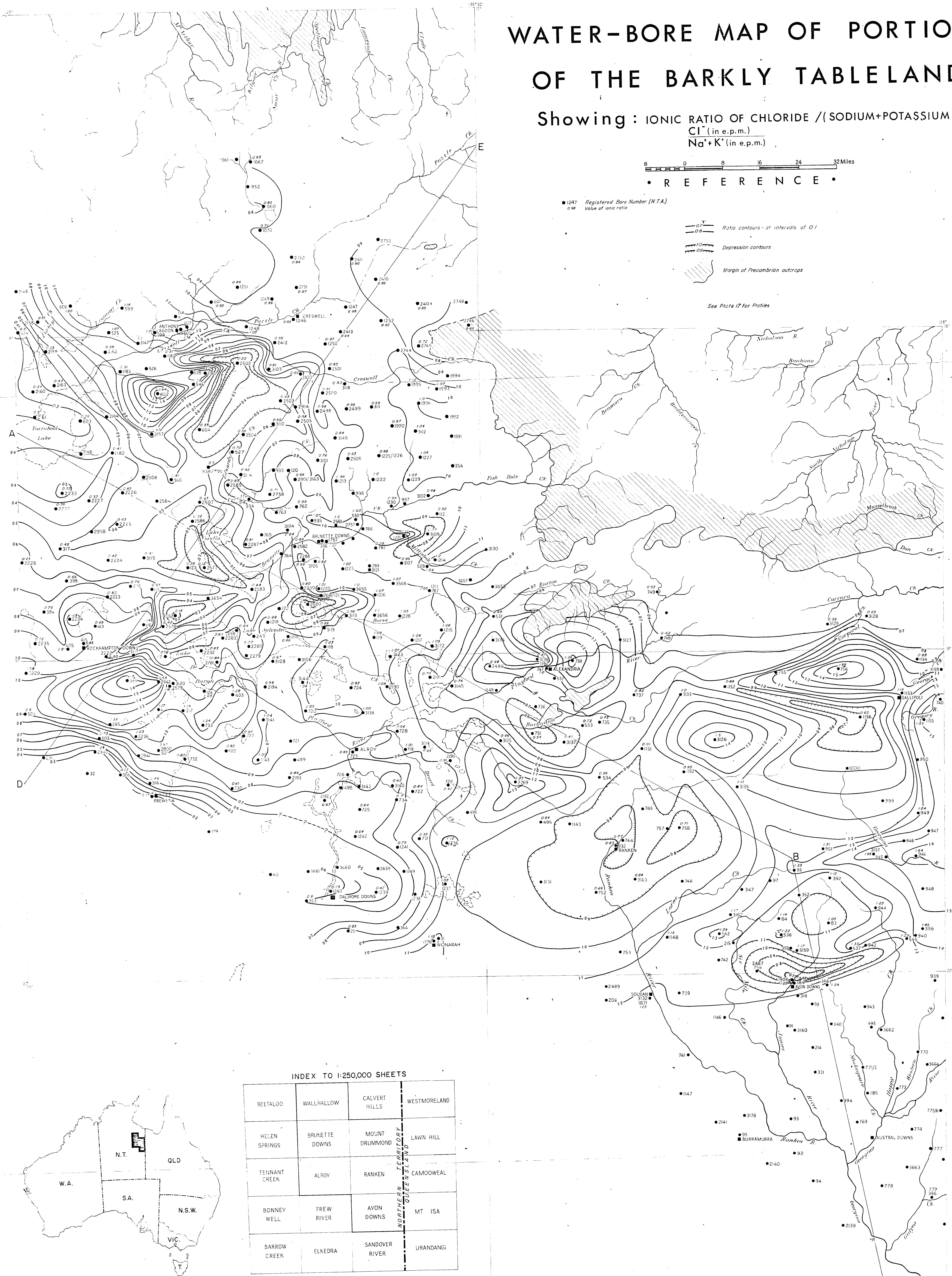
To accompany Record Nº 1966/11

NT/A/42 G.M.

WATER-BORE MAP OF PORTION OF THE BARKLY TABLELAND

Showing: IONIC RATIO OF CHLORIDE /(SODIUM+POTASSIUM)

$$\frac{Cl^{-}\text{ (in e.p.m.)}}{Na^{+}+K^{+}\text{ (in e.p.m.)}}$$



NT/A/49 G.M.

Bureau of Mineral Resources Geology & Geophysics September 1963 & May 1965

To accompany Record Nº 1966/11

Plate 13

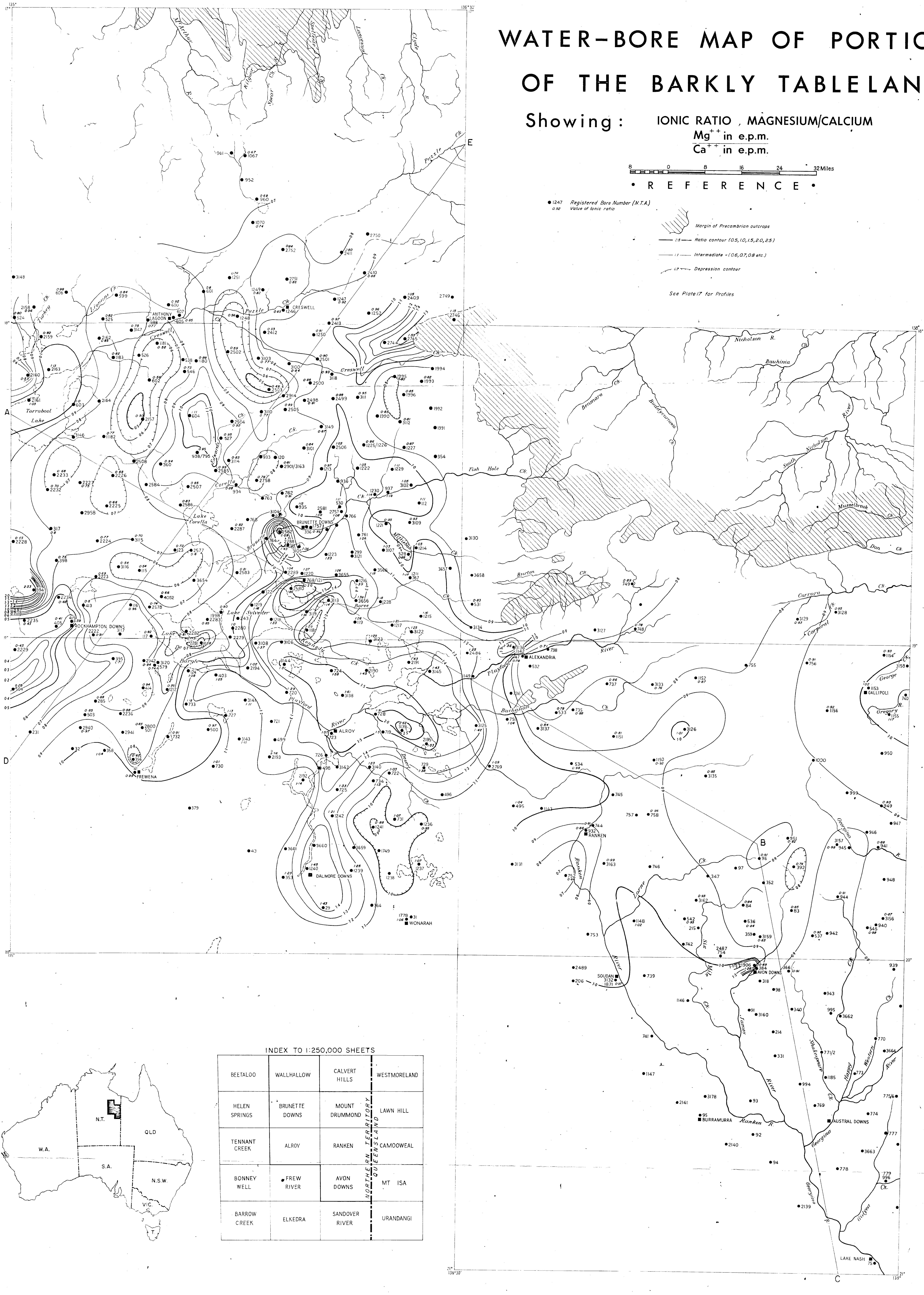
WATER–BORE MAP OF PORTION OF THE BARKLY TABLELAND

Showing: IONIC RATIO , MAGNESIUM/CALCIUM $\frac{Mg^{++} \text{ in e.p.m.}}{Ca^{++} \text{ in e.p.m.}}$

• R E F E R E N C E •

● 1247	Registered Bore Number (N.T.A.)
0.92	Value of Ionic ratio
▨	Margin of Precambrian outcrops
—— 0.5 ——	Ratio contour (0.5, 1.0, 1.5, 2.0, 2.5)
—— 1.1 ——	Intermediate " (0.6, 0.7, 0.8 etc.)
—— 0.7 ┬┬┬	Depression contour

See Plate 17 for Profiles



INDEX TO 1:250,000 SHEETS

BEETALOO	WALLHALLOW	CALVERT HILLS		WESTMORELAND
HELEN SPRINGS	BRUNETTE DOWNS	MOUNT DRUMMOND	NORTHERN TERRITORY	LAWN HILL
TENNANT CREEK	ALROY	RANKEN	QUEENSLAND	CAMOOWEAL
BONNEY WELL	FREW RIVER	AVON DOWNS		MT ISA
BARROW CREEK	ELKEDRA	SANDOVER RIVER		URANDANGI

Bureau of Mineral Resources. Geology & Geophysics. September 1963. & May 1965

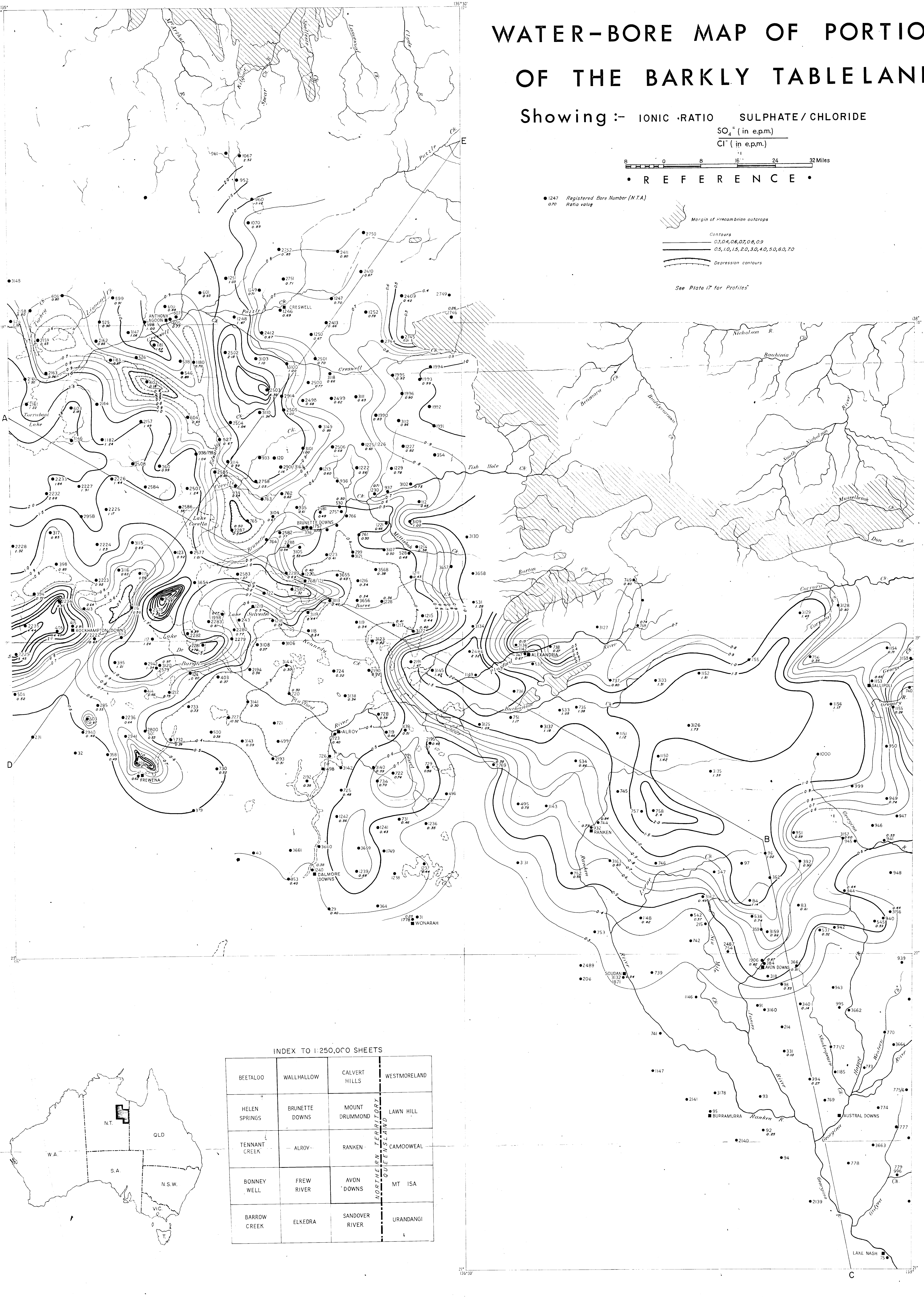
To accompany Record Nº 1966/11

NT/A/39 G.M.

WATER-BORE MAP OF PORTION OF THE BARKLY TABLELAND

Showing :- IONIC RATIO SULPHATE / CHLORIDE

$\dfrac{SO_4^{=}\text{ (in e.p.m.)}}{Cl^{-}\text{ (in e.p.m.)}}$



INDEX TO 1:250,000 SHEETS

BEETALOO	WALLHALLOW	CALVERT HILLS	WESTMORELAND
HELEN SPRINGS	BRUNETTE DOWNS	MOUNT DRUMMOND	LAWN HILL
TENNANT CREEK	ALROY	RANKEN	CAMOOWEAL
BONNEY WELL	FREW RIVER	AVON DOWNS	MT ISA
BARROW CREEK	ELKEDRA	SANDOVER RIVER	URANDANGI

NORTHERN TERRITORY
QUEENSLAND

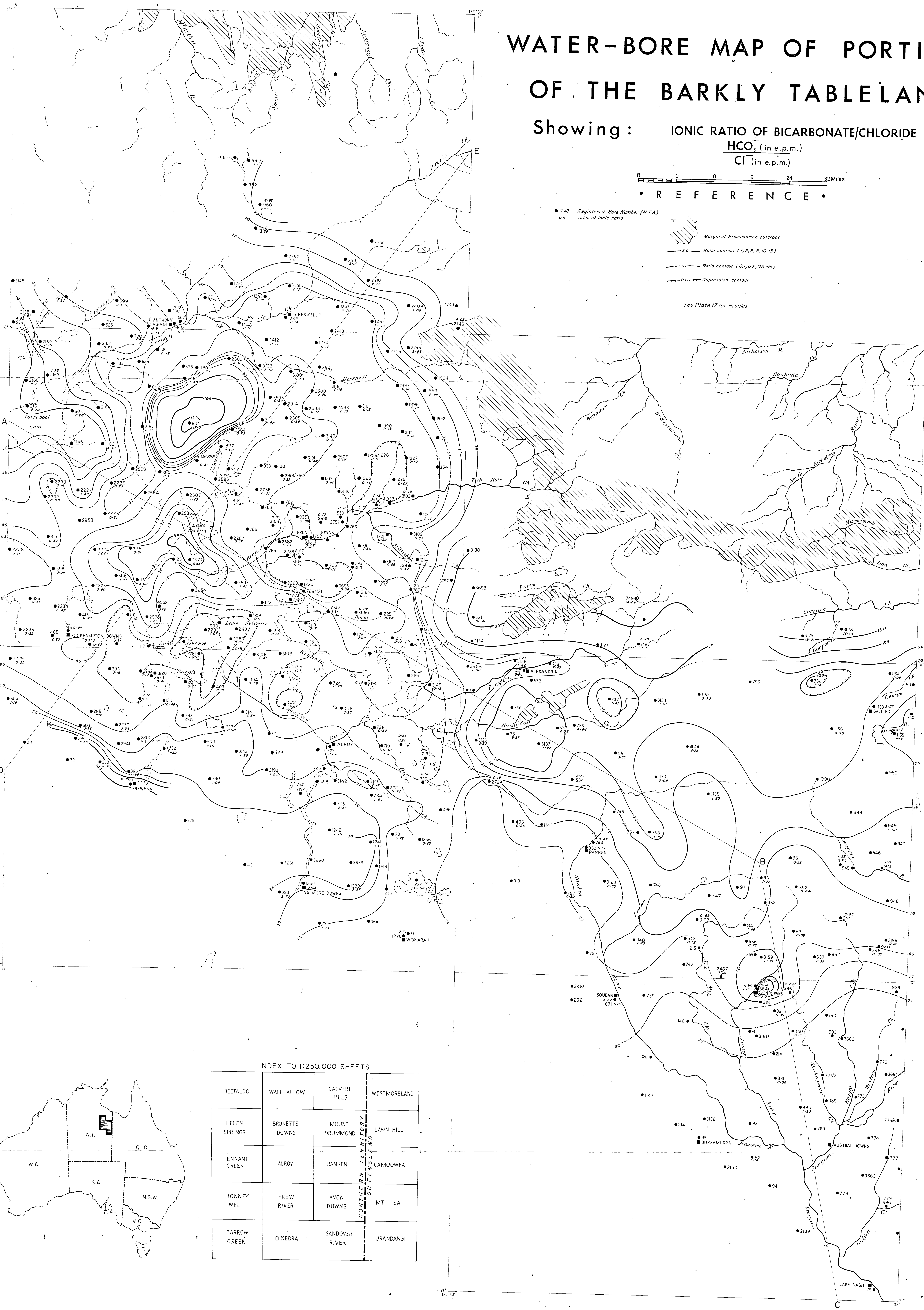
Bureau of Mineral Resources, Geology & Geophysics. September 1963 & May 1965

To accompany Record No 1966/11

WATER-BORE MAP OF PORTION OF THE BARKLY TABLELAND

Showing: IONIC RATIO OF BICARBONATE/CHLORIDE

$$\frac{HCO_3^- \text{(in e.p.m.)}}{Cl^- \text{(in e.p.m.)}}$$



INDEX TO 1:250,000 SHEETS

BEETALOO	WALLHALLOW	CALVERT HILLS	WESTMORELAND
HELEN SPRINGS	BRUNETTE DOWNS	MOUNT DRUMMOND	LAWN HILL
TENNANT CREEK	ALROY	RANKEN	CAMOOWEAL
BONNEY WELL	FREW RIVER	AVON DOWNS	MT ISA
BARROW CREEK	ELKEDRA	SANDOVER RIVER	URANDANGI

NORTHERN TERRITORY
QUEENSLAND

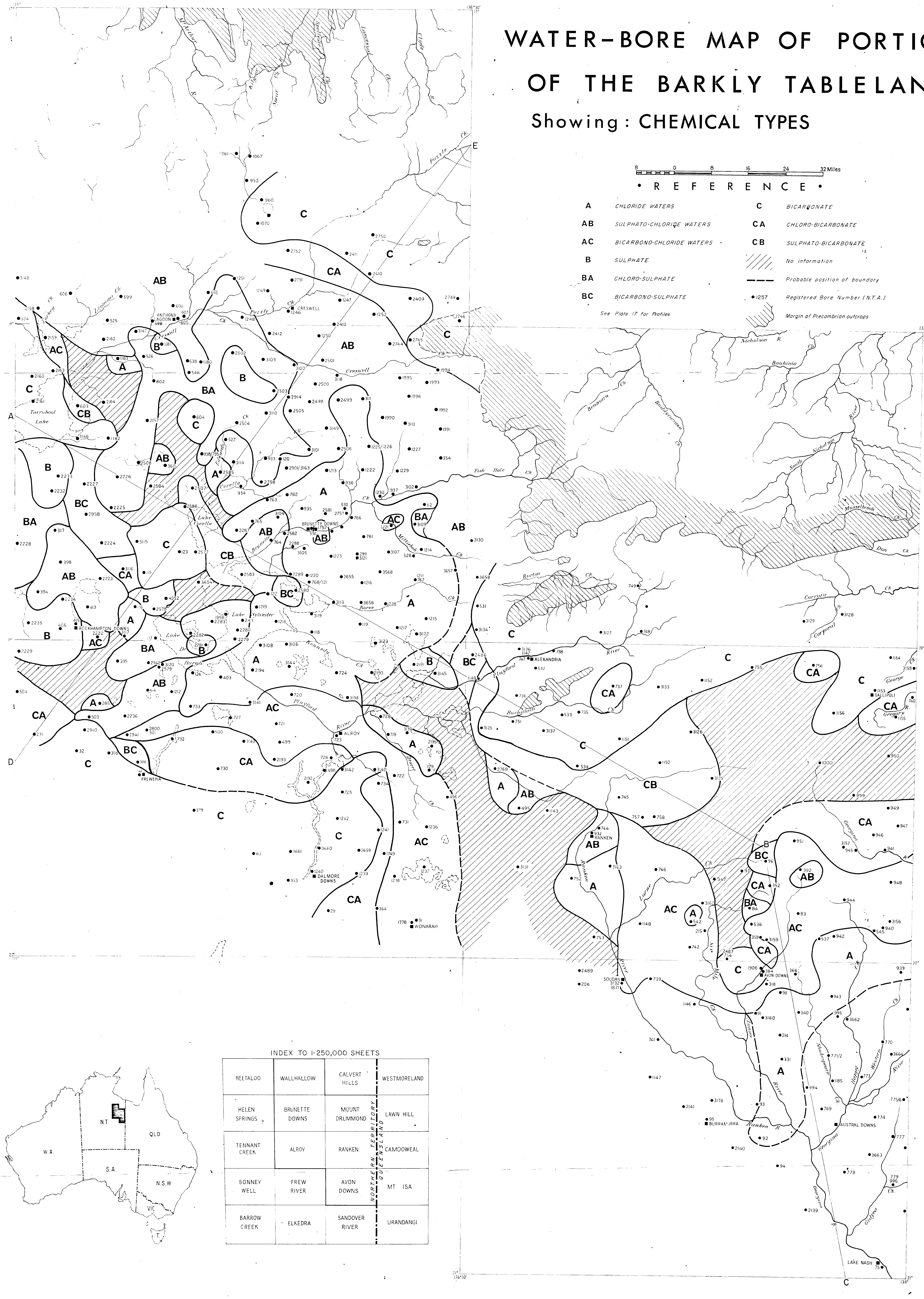
Bureau of Mineral Resources, Geology & Geophysics. September 1963 & May 1965

To accompany Record Nº 1966/11

NT/A/47 G.M.

WATER-BORE MAP OF PORTION OF THE BARKLY TABLELAND

Showing: CHEMICAL TYPES



Bureau of Mineral Resources, Geology & Geophysics. September 1963 & May 1965.

To accompany Record N° 1966/11

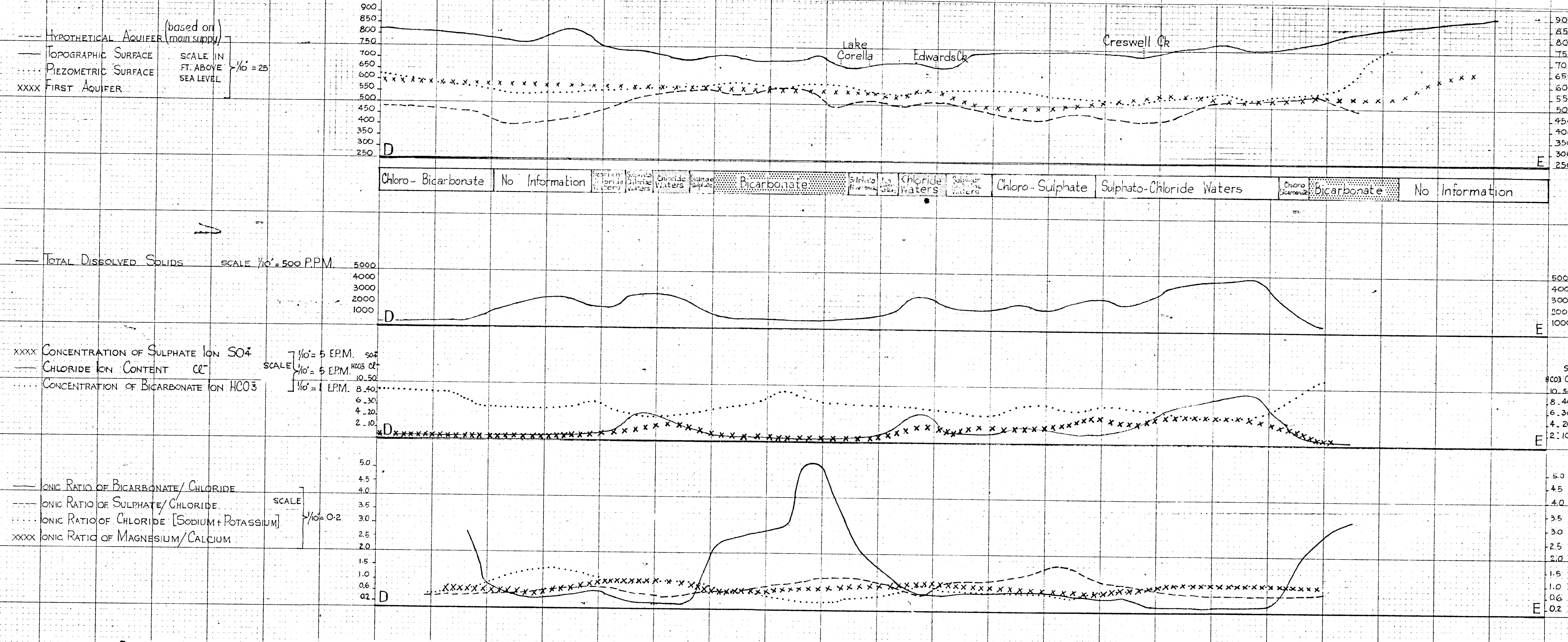
NT/A/43 G.M.

PLATE 17

PROFILES SHOWING OCCURRENCE AND CHEMISTRY OF GROUNDWATER ON THE BARKLY TABLELAND

PROFILES ALONG SECTION A B C.

PROFILES ALONG SECTION D E.



Bureau of Mineral Resources, Geology and Geophysics

To accompany Record 1966/11

May 1965

NT/A/110

(Giving main hydrological parameters)

BRUNETTE DOWNS 1:250,000 SHEET AREA

Reg. No.	Station No. or Name	Position	Elevation in feet	Total Depth in feet	Rock Units	Depth of Aquifers * Main Supply in feet	Depth Standing Water Level in feet	Pump Depth in feet	Supply in g.p.h.	Quality	Remarks
112	Brunette 22	6 miles south-west of Coolibah W.H. and 11 miles north of Mitticbah Creek	765	258	Cambrian dolomite	211, 218 and 258*	191	230	3000	4600 ppm	
115	Brunette 25	9 miles from Rockhampton Downs boundary on Brunette-Rockhampton track	710	175	Anthony Lagoon Beds	137, 150*	135	135	2500	540 ppm	
116	Brunette 26	8 miles south of Bore No. 25	695	155	Anthony Lagoon Beds	130	125	138	2400	2869 ppm	
117	Brunette 27	On western side of Lake De Burgh, 8 miles south-east of Bore 26	680	187	Anthony Lagoon Beds	124	110	123	2000	Good 3012 ppm	
118	Brunette 28	23 miles south of Brunette Downs Homestead, on track to Alroy Homestead.	685	145	Anthony Lagoon Beds	116*, 140	116 (?)	125	3000+	2340 ppm	
119	Brunette 29	11 miles east by north of No. 28 and 3 miles south of Boree Creek	690	167	Cambrian dolomite	145?	141	149	3600	Good 2672 ppm	
120	Brunette 30	East of Corella Creek and 1.5 miles north of Barkly Stock Route	740	213	Anthony Lagoon Beds	184	176	197	3000+	Good	
121	Brunette 31	15 miles south of Brunette Downs Homestead	710	180	Anthony Lagoon Beds	-	-	-	-	-	Was originally equipped but now abandoned.
122	Brunette 32	Half way between Nos. 15 and 23 (Not located)	680 (?)	120	Anthony Lagoon Beds	115	110	-	unlimited	very poor	Never equipped - abandoned
123	Brunette 33	12 miles west by north of Brunette Creek, on Brunette-Rockhampton Road	680	229	Anthony Lagoon Beds	120 (1st supply)	-	207	1800	Fresh 1018 ppm	
243	Brunette 23	Lake Sylvester; 15 miles west by north of No. 28	725	224	Anthony Lagoon Beds	148, 195	165 (?)	185	1500	Poison water	Bad water, now abandoned
299	Brunette 35	14 miles east-south-east of Homestead. Position uncertain as not located.	725 (?)	185	Cambrian dolomite	160	-	-	-	Not fit for stock	Never equipped - abandoned.
317	Rockhampton 13	21 miles north-north-west of Rockhampton Downs Homestead	710	217	Cambrian dolomite	-	169	-	Good	Good 1851 ppm	
336	Brunette 36	Brunette Homestead.	718	387	Anthony Lagoon Beds	147	-	250	1600	Unfit for humans	Abandoned as at 11/8/61.
354	Brunette 21	East of Brunette Creek, 5 miles north of Coolibah W.H.	795	304	Cambrian dolomite	251, 261, 285*	213	275	2000	-	Not working in 1962
360	Brunette 18	14 miles west-south-west of Boundary Bore, Barkly Stock Route	670	240	Anthony Lagoon Beds	151, 191, 202*	133	161	2000	3240 ppm	

APPENDIX B (CONTD.)

Reg. No.	Station No. or Name	Position	Elevation in feet	Total Depth in feet	Rock Units	Depth of Aquifers * Main Supply in feet	Depth Standing Water Level in feet	Pump Depth in feet	Supply in g.p.h.	Quality	Remarks
394	Rockhampton 11	11 miles north-west of Rockhampton Downs Homestead	717	150	Cambrian	-	114	-	Good	Good 1819 ppm	
398	Rockhampton 10	14 miles north-north-west of Rockhampton Downs Homestead	725	175	Cambrian	-	130	-	Good	Fair 2582 ppm	
405	Rockhampton 12	4 miles west-south-west of Rockhampton Downs Homestead on Brunchilly road	700	518	Cambrian	-	150	-	Good	Good 3148 ppm	
413	Rockhampton 9	5 miles north-north-east of Rockhampton Downs Homestead on Anthony Lagoon Road	738	227	Cambrian	-	153	-	Good	Good 1688 ppm	
415/1920	Rockhampton 5	Rockhampton Downs Homestead	729	298/671	Cambrian	-	156/150	-	-	Brackish 2746 ppm	No. 1920 drilled in 1948 to improve supply.
526	B.S.R.-Desert	4 miles south of Creswell Creek	705	290	Anthony Lagoon Beds	167, 287*	140	230	1500	Fair	
527	B.S.R. Boundary	On Edwards Creek	725	208	Anthony Lagoon Beds	-	160	181	1400	Good for Stock 2858 ppm	
528	B.S.R. Mittiebah	Mittiebah Creek	750	219	Cambrian dolomite	185	185	209	1600	Fair 858 ppm	
530	B.S.R. Brunette Creek	1 mile west of Brunette Creek	750	256	Cambrian dolomite	210	165	214	1500	Good for Stock 3500 ppm	
538	Anthony Lagoon Old Dip	6 miles south of Anthony Lagoon Aerodrome	748	240	Anthony Lagoon Beds	175	160	190	1800	Good for Stock	
546	B.S.R. Wendy	9 miles south of Anthony Lagoon Aerodrome	740	252	Anthony Lagoon Beds	195, 252*	162	208	1200	Fair 1738 ppm	
602	Anthony Lagoon 7	5 miles south of Barkly Stock Route, on Anthony Lagoon-Rockhampton Downs Road	717	418	Anthony Lagoon Beds	245, 380	240	-	2250	2410 ppm	
603	Anthony Lagoon 9	2 miles east of Tarrabool Lake	690	197	Anthony Lagoon Beds	170	-	180	2000	850 ppm	
604	Anthony Lagoon 1 (Blue-bush)	Off Barkly Stock Route, 22 miles south of Anthony Lagoon Homestead	736	260	Anthony Lagoon Beds	172, 260*	192	-	3000	504 ppm	
760	Brunette 7	Not located	-	-	-	-	-	-	-	-	Abandoned.
761	Brunette 8	15 miles east of Homestead and 7 miles south of Long W.H.	730	281	Cambrian dolomite	-	172	179	2000	1491 ppm	
762	Brunette 9	8 miles north-north-west of Homestead	715	245	Anthony Lagoon Beds	-	169	180	2000	3779 ppm	
763	Brunette 10	9 miles north-west of Homestead on tributary of Corella Creek	670	289	Anthony Lagoon Beds	289	154	-	2000	-	Abandoned - casing collapsed

APPENDIX B (CONTD.)

Reg. No.	Station No. or Name	Position	Elevation in feet	Total Depth in feet	Rock Units	Depth of Aquifers * Main Supply in feet	Depth Standing Water Level in feet	Pump Depth in feet	Supply in g.p.h.	Quality	Remarks
764	Brunette 11	On Brunette Creek 7 miles south-west of Brunette Downs Homestead	685	161	Anthony Lagoon Beds	-	115	-	-	-	Casing collapsed. Abandoned
765	Brunette 12	11 miles west of Brunette Downs Homestead	715	700	Anthony Lagoon Beds	267, 520, 700	157	240	2000	-	Caved in - abandoned
766	Brunette 13	12 miles east by north of Brunette Downs Homestead	710	381	Cambrian dolomite	124, 373	120	-	2250	-	Not equipped. Abandoned
767+	Brunette 14	6 miles south of Mittiebah Creek, and one mile north of Boree Creek	730	283	Cambrian dolomite	-	173	-	3000	-	Abandoned; new bore on site+
768	Brunette 15	15 miles south of Brunette Downs Homestead	710	-	-	-	-	-	-	-	Abandoned.
795	Brunette 6	5 miles east of Edwards Creek	712	393	Anthony Lagoon Beds	195, 275, 297, 378*	160	231	2500	3220 ppm	
933	Brunette 1	Corella Creek on Barkly Stock Route	705	255	Anthony Lagoon Beds	180	-	-	-	-	Casing collapsed. Abandoned
934	Brunette Corella 2	Corella Creek near Edwards Creek	710	212	Anthony Lagoon Beds	160, 200*	-	165	2000	1718 ppm	
935	Brunette 3	4 miles north of Brunette Downs Homestead	715	357	Anthony Lagoon Beds	-	165	180	2000	4480 ppm	
936	Brunette 4	13 miles north-east of Homestead	745	252	Cambrian dolomite	180	160	-	2000	-	Casing collapsed. Abandoned.
937	Brunette 5	Southern Branch of Brunette Creek, 8 miles east of Dingo W.H.	725	180(?)	Cambrian dolomite	180(?)	180	-	2000	-	Casing collapsed. Abandoned.
938	Brunette 6	5 miles east of Edwards Creek	712	267	Anthony Lagoon Beds	240	-	-	2000	-	Abandoned; see Reg. No. 795
1180	Anthony Lagoon 10	10 miles south by east of Anthony Lagoon Homestead	725	231	Anthony Lagoon Beds	189	-	-	1600	Unfit for humans 2010 ppm	
1181	Anthony Lagoon 11	5 miles south-south-west of Anthony Lagoon Aerodrome	720	309	Anthony Lagoon Beds	175, 265, 299*	150	-	1800	Unfit for humans 3880 ppm	
1182	Anthony Lagoon 12	On Rocky Creek, east of Tarrabool Lake	700	150	Anthony Lagoon Beds	114	107	132	-	Good 670 ppm	
1183	Anthony Lagoon 13	7 miles east of Adder W.H. on Creswell Creek	695	275	Anthony Lagoon Beds	150, 262*	136	250	-	Unfit for humans 3360 ppm	
1211	Brunette 14	6 miles south of Mittiebah Creek and one mile north of Boree Creek	730	202	Cambrian dolomite	-	173(?)	186	2000	2964 ppm	
1213	Brunette 37	14 miles north-north-east of Brunette Downs Homestead on Creswell road	740	356	Anthony Lagoon Beds	185	-	240	Small	3566 ppm	Main aquifer below 185.

+ see No. 1211

APPENDIX B (CONTD.)

Reg. No.	Station No. or Name	Position	Elevation in feet	Total Depth in feet	Rock Units	Depth of Aquifers * Main Supply in feet	Depth Standing Water Level in feet	Pump Depth in feet	Supply in g.p.h.	Quality	Remarks
1214	Brunette 38	On Mittiebah Creek, 7 miles north of Boree Creek	730	229	Cambrian dolomite	220	-	212/227	2000	2901 ppm	
1215	Brunette 39	9 miles south by east of No. 14 (R1211)	735	301	Cambrian dolomite	-	-	249	2000	4217 ppm	
1216	Brunette 40	4 miles east of White W.H. and 7 miles north of Boree Creek	710	187	Cambrian dolomite	-	-	175	2000	3019 ppm	
1217	Brunette 41	6 miles south of Boree Creek and 19 miles east of No. 28	710	353	Cambrian dolomite	-	-	170	1400	3726 ppm	
1218	Brunette 42	Lake Sylvester, 21 miles south by west of Brunette Homestead	685	242	Anthony Lagoon Beds	-	-	126/138	2400	Good 2163 ppm	
1219	Brunette 43	Lake Sylvester, 20 miles south-south-west of Brunette Downs Homestead	700	127	Anthony Lagoon Beds	120	109	115	2500	5720 ppm	
1220	Brunette 44	11 miles south of Brunette Downs Homestead, on Alroy Downs Road	700	225	Anthony Lagoon Beds	220	133	160	2500	4870 ppm	
1221	Brunette 45	On Mittiebah Creek, 3.5 miles north of Barkly Stock Route	745	249	Cambrian dolomite	-	-	200	2800	840 ppm	rose 4 ft.
1222	Brunette 46	7 miles north of Dingo W.H. on Brunette Creek	755	232	Cambrian dolomite	-	178	210	2400	3843 ppm	
1223	Brunette 47	9 miles south-east of Brunette Downs Homestead, near Anthony Lagoon Beaf Road	720	227	Cambrian dolomite	-	176	199	2200	5079 ppm	
1225	Brunette 17	12 miles north by east of Dingo W.H. on Brunette Creek	785	250	Cambrian dolomite	-	-	235	-	4078 ppm	
1226	Brunette 17	12 miles north by east of Dingo W.H. on Brunette Creek	785	259	Cambrian dolomite	-	-	-			Abandoned
1227	Brunette 19	Headwaters of Brunette Creek	755	292	Cambrian dolomite	196, 268*	191	216	2400	5274 ppm	
1228	Brunette 48	On Boree Creek	710	185	Cambrian dolomite	-	-	170	2400	2620 ppm	
1229	Brunette 49	North branch of Brunette Creek	760	230	Cambrian dolomite	-	-	215	2400	7212 ppm	
1230	Brunette 50	Junction Fish-hole and Brunette Creeks	730	256	Cambrian dolomite	-	-	232	1400	6589 ppm	
1250	Creswell 5	9 miles north-north-west of Creswell Creek on Brunette Downs-Creswell Road	765	298	Anthony Lagoon Beds	210, 275	-	257	-	4090 ppm	
1757	Brunette Schoolhouse	Homestead	718	200	Anthony Lagoon Beds	142	137	190	1400	Poor 4290 ppm	Abandoned
1990	Brunette D2	14 miles south-east of Wire Yard W.H. on Creswell Creek	770	325	Cambrian dolomite	234, 298*	234	260	2000	4010 ppm	

APPENDIX B (CONTD)

Reg. No.	Station No. or Name	Position	Elevation in feet	Total Depth in feet	Rock Units	Depth of Aquifers * Main Supply in feet	Depth Standing Water Level in feet	Pump Depth in feet	Supply in g.p.h.	Quality	Remarks
1991	Brunette D3	11 miles north of Coolibah W.H. on Fish Hole Creek	790	345	Cambrian dolomite	215, 315*	215	-	1600	-	
1992	Brunette D4	16 miles north of Coolibah W.H. on Fish Hole Creek	785	345	Cambrian dolomite	235, 310*	240	270(a)	1800	Fair	
1993	Brunette D5	8 miles south-east of Bowgan W.H. on Creswell Creek	790	304	Cambrian dolomite	277	232	251	1800	Fair 1250 ppm	
1994	Brunette D6	3 miles south-south-west of Long W.H. on Creswell Creek	800	402	Cambrian dolomite	252, 297, 347*	240	-	1500	Bad	Not equipped in 1962
1995	Brunette D8	4 miles south by east of Bowgan W.H. on Creswell Creek	790	291	Cambrian dolomite	235, 272*	210	270	1800	Fair 3710 ppm	
1996	Brunette D9	8 miles south by east of Bowgan W.H. on Creswell Creek	780	284	Cambrian dolomite	232, 262*	220	270	1650	Fair 3530 ppm	
1998	Brunette D14	Lake Sylvester, 8 miles south of Brunette Creek	645	196	Anthony Lagoon Beds	105, 110, 185*	105	156(a)	2000	Fair 6708 ppm	
2157	Anthony Lagoon 14	21 miles south-south-west of Anthony Lagoon Aerodrome	735	400	Anthony Lagoon Beds	185, 350*	-	375	1800	Unfit for humans 3990 ppm	
2159	Anthony Lagoon 16	11 miles north-west of Adder W.H. on Creswell Creek	695	150	Anthony Lagoon Beds	130, 137	-	-	1800	Unfit for humans 1170 ppm	
2160	Anthony Lagoon 17	3 miles north-west of Tarrabool Lake	690	134	Anthony Lagoon Beds	123	113	134	1800	Fit for humans 630 ppm	
2161	Anthony Lagoon 18	North-western margin of Tarrabool Lake	700	230	Anthony Lagoon Beds	-	-	190	-	Fit for humans 602 ppm	
2162	Anthony Lagoon 19	6 miles north-north-east of Adder W.H. on Creswell Creek	685	170	Anthony Lagoon Beds	158	130	-	2000	Unfit for humans 2340 ppm	
2163	Anthony Lagoon 20	2 miles north of Tarrabool Lake	670	160	Anthony Lagoon Beds	120, 146*	-	-	1920	1060 ppm	
2164	Anthony Lagoon 21	7 miles east of Tarrabool Lake	735	238	Anthony Lagoon Beds	213, 228	-	232	1440	-	
2222	Rockhampton 1	5 miles east-south-east of Rockhampton Downs Homestead	740	272	Cambrian	-	169	-	1500	1376 ppm	
2223	Rockhampton 2	11 miles north-north-east of Rockhampton Downs Homestead on Anthony Lagoon Road	710	206	Anthony Lagoon Beds	-	139	-	1500	1506 ppm	
2224	Rockhampton 17	19 miles north by east of Rockhampton Downs Homestead	705	194	Anthony Lagoon Beds	-	145	-	-	1263 ppm	
2225	Rockhampton 18	27 miles north by east of Rockhampton Downs Homestead	670	180	Anthony Lagoon Beds	-	-	-	-	4230 ppm	

(a) Position of pump during test.

APPENDIX B (CONTD)

Reg. No.	Station No. or Name	Position	Elevation in feet	Total Depth in feet	Rock Units	Depth of Aquifers ^{x} Main Supply in feet	Depth Standing Water Level in feet	Pump Depth in feet	Supply in g.p.h.	Quality	Remarks
2226	Rockhampton 19	34 miles north by east of Rockhampton Downs Homestead on Anthony Lagoon Road	703	210	Anthony Lagoon Beds	-	-	-	-	3814 ppm	
2227	Rockhampton 20	31 miles north of Rockhampton Downs Homestead	730	210	Anthony Lagoon Beds	-	-	-	-	1353 ppm	
2228	Rockhampton 21	21 miles north-west of Rockhampton Downs Homestead	680	187	Anthony Lagoon Beds	-	150	-	-	5093 ppm	
2232	Rockhampton 25	30 miles north-north-west of Rockhampton Downs Homestead	720	196	Anthony Lagoon Beds	-	140	-	-	2762 ppm	
2233	Rockhampton 26	33 miles north by west of Rockhampton Downs Homestead	725	210	Anthony Lagoon Beds	-	129	-	-	4250 ppm	
2234	Rockhampton 27	6 miles north-west of Rockhampton Downs Homestead	740	262	Anthony Lagoon Beds	-	150	-	-	3078 ppm	
2235	Rockhampton 28	10 miles west of Rockhampton Downs Homestead on Brunchilly Road	730	288	Anthony Lagoon Beds	-	155	-	-	3532 ppm	
2279	Brunette D10	Lake Sylvester, 19 miles south of Brunette Creek	710	286	Anthony Lagoon Beds	115, 235^{x}	115	197/225 (a)	360	-	Abandoned - Site moved
2280	Brunette D10	Lake Sylvester, 15 miles south of Brunette Creek	710	195	Anthony Lagoon Beds	130, 160, 176^{x}	130	164	1800	Poor 10850 ppm	Abandoned in 1962
2282	Brunette D12	North-eastern corner of Lake De Burgh	655	193	Anthony Lagoon Beds	105, 173^{x}	120	-	1500	Fair 5362 ppm	
2283	Brunette D13	5 miles north-east of D12	633	209	Anthony Lagoon Beds	105, 181^{x}	105	155	1800	Fair 5794 ppm	
2287	Brunette D19	East of Lake Corella and 7 miles north of Brunette Creek	665	412	Anthony Lagoon Beds	103, 280, 390^{x}	95	365(a)	1200	Good 1806 ppm	
2288	Brunette D20	6 miles south by west of Brunette Homestead	715	234	Anthony Lagoon Beds	175, 215^{x}	175	-	1400	Fair 10546 ppm	
2289	Brunette D21	North-eastern Lake Sylvester, 5 miles east of Joe W.H.	670	276	Anthony Lagoon Beds	123, 190, 255^{x}	120	194(a)	1500	Fair 4815 ppm	
2412	Creswell 9	18 miles north-west of Wire Yard W.H. on Creswell Creek	740	265	Anthony Lagoon Beds	191, 241^{x}	176	225	1500	3787 ppm	
2498	Brunette D22	6 miles north of Buffalo W.H. on Corella Creek	760	322	Cambrian dolomite	230, 302^{x}	230	-	2000	Fair 3490 ppm	
2499	Brunette D23	5 miles south of Wire Yard W.H. on Creswell Creek	760	326	Cambrian dolomite	220, 260, 305^{x}	220	257	1600	Fair 4242 ppm	
2500	Brunette D24	6 miles south-west of Wire Yard W.H. on Creswell Creek	755	350	Anthony Lagoon Beds	239, 330^{x}	239	278	1600	Good 3201 ppm	
2501	Brunette D25	1 mile north of Creswell Creek and 2 miles west of Brunette Downs-Creswell Road	750	352	Anthony Lagoon Beds	214, 334^{x}	214	-	1500	Good 4129 ppm	

(a) Position of pump during test

APPENDIX B (CONTD)

Reg. No.	Station No. or Name	Position	Elevation in feet	Total Depth in feet	Rock Units	Depth of Aquifers * Main Supply in feet	Depth Standing Water Level in feet	Pump Depth in feet	Supply in g.p.h.	Quality	Remarks
2502	Brunette D26	24 miles west by north of Wire Yard W.H. on Creswell Creek	755	355	Anthony Lagoon Beds	200, 325*	110	339(a)	1000	Fair 2208 ppm	Not equipped in 1962
2503	Brunette D27	11 miles north by west of Lignum W.H. on Corella Creek	730	320	Anthony Lagoon Beds	203, 300*	200	-	3600	Fair 2803 ppm	
2504	Brunette D28	Headwaters of Edwards Creek	720	343	Anthony Lagoon Beds	200, 328*	189	-	2800	Good 1660 ppm	
2505	Brunette D29	6 miles north of Lignum W.H. on Corella Creek	725	281	Anthony Lagoon Beds	187, 265*	180	-	3600	Fair 1231 ppm	
2506	Brunette D30	19 miles north-north-east of Brunette Downs Homestead	755	280	Anthony Lagoon Beds	230, 260*	230	-	1800	Fair 4190 ppm	
2507	Brunette D31	6 miles north-west of Corella Lagoon	706	235	Anthony Lagoon Beds	165, 215*	160	-	3600	Good 1010 ppm	
2508	Brunette D32	18 miles west-north-west of Corella Lagoon	680	200	Anthony Lagoon Beds	153, 181*	150	-	2400	Fair	
2577	Brunette D36	Immediately south of Corella Lake	685	304	Anthony Lagoon Beds	108, 290*	108	-	3000	Fair 483 ppm	
2578	Brunette D37	2 miles north-west of Lake De Burgh	700	220	Anthony Lagoon Beds	160, 220*	140	-	2600	Fair 1245 ppm	
2580	Brunette D39	North-eastern corner of Lake Sylvester	690	302	Anthony Lagoon Beds	202, 280*	180	-	2000	Good 972 ppm	
2581	Brunette D40	On Anthony Lagoon Beef Road, 5 miles west of Racecourse	730	266	Anthony Lagoon Beds	130, 240*	130	-	3600	Fair 2875 ppm	
2582	Brunette D41	3 miles south-west of Brunette Downs Homestead	675	436	Anthony Lagoon Beds	140, 296*	120	370(a)	2050	5508 ppm	
2583	Brunette D38	North of Lake Sylvester and 2.5 miles south of Brunette Creek	692	252	Anthony Lagoon Beds	140, 240*	120	-	2600	Good 829 ppm	
2584	Brunette D33	24 miles west by north of Corella Lagoon	695	565	Anthony Lagoon Beds	-	-	-	-	-	Dry Hole
2585	Brunette D34	On Edwards Creek and 4 miles north of Corella Creek	698	208	Anthony Lagoon Beds	140, 188*	140	-	2400	Fair 3099 ppm	
2586	Brunette D35	1.5 miles north-west of Lake Corella	700	182	Anthony Lagoon Beds	130, 155*	130	-	3000	Fair 711 ppm	
2744	Creswell	5 miles north by west of Bowgan W.H. on Creswell Creek	760	200	Anthony Lagoon Beds	-	-	-	-	-	Dry Hole
2745	Creswell 13	5 miles north-north-east of Bowgan W.H. on Creswell Creek	745	355	Anthony Lagoon Beds	325	140	-	2050	Fair 471 ppm	
2757	Brunette-Racecourse	Racecourse	720	251	Cambrian dolomite	196, 223	196	-	4880	Fair	

(a) Position of pump during test

APPENDIX B (CONTD)

Reg. No.	Station No. or Name	Position	Elevation in feet	Total Depth in feet	Rock Units	Depth of Aquifers * Main Supply in feet	Depth Standing Water Level in feet	Pump Depth in feet	Supply in g.p.h.	Quality	Remarks
2758	Brunette D7	14 miles north-west of Brunette Homestead and 3 miles east of Corella Creek	732	252	Anthony Lagoon Beds	190	140	-	2000	Fair 2110 ppm	
2901	B.S.R. Bishops	6 miles south-east of Corella Creek	735	259	Anthony Lagoon Beds	205	170	-	2000	Fair 2522 ppm	
2914	Nemo Bore	9 miles north of Lignum W.H. on Corella Creek	735	302	Anthony Lagoon Beds	230, 250-280*.	203	-	1200	Fair	Not equipped in 1962
2958	Rockhampton 33	24 miles north of Rockhampton Downs Homestead	695	174	Anthony Lagoon Beds	145, 165	125	-	-	-	
3100	Brunette K1	On Creswell Creek, 10 miles west of Brunette Downs Creswell Road	735	258	Anthony Lagoon Beds	-	-	258	-	1976 ppm	
3101	Brunette K2	4 miles south by west of Buffalo W.H. on Corella Creek	750	493	Anthony Lagoon Beds	-	-	258	-	2097 ppm	
3102	Brunette K3	On Fish-Hole Creek, six miles east of Brunette Creek	740	251	Cambrian dolomite	210, 240*	-	212	1800	Good 4702 ppm	
3103	Brunette K4	17 miles west by north of Wire Yard W.H. on Creswell Creek	740	288	Anthony Lagoon Beds	190, 243*	-	223	-	3544 ppm	
3104	Brunette K5	5 miles north-west of Brunette Downs Homestead	720	705	Anthony Lagoon Beds	172, 500, 687*	167	200	-	2224 ppm	
3105	Brunette K6	5 miles south of Brunette Downs Homestead, on Alroy Downs Road	725	377	Anthony Lagoon Beds	100, 220, 357*	195	240	2000	3924 ppm	
3107	Brunette K8	20 miles east-south-east of Brunette Downs Homestead	725	220	Cambrian dolomite	200, 210	194	207	-	1306 ppm	
3109	Brunette 60	25 miles east of Brunette Downs Homestead	770	274	Cambrian dolomite	229, 265*	198	225	1800	1980 ppm	
3110	Brunette 59	On Anthony Lagoon Beef Road, 7 miles north-west of Lignum W.H. on Corella Creek	740	335	Anthony Lagoon Beds	330	195	250	3600	1920 ppm	
3111	Brunette 58	8 miles south-east of Wire Yard W.H. on Creswell Creek	775	271	Cambrian dolomite	217, 255*	247	247	3300	4237 ppm	
3112	Brunette 57	Headwaters of Brunette Creek	755	272	Cambrian dolomite	250	200	237	2400	4162 ppm	
3113	Brunette 56	On Boree Creek, on eastern margin of Lake Sylvester	690	256	Cambrian dolomite	-	-	193	2200	2935 ppm	
3114	Brunette 55	2.5 miles east of Edwards Creek and 4 miles south of Barkly Stock Route	666	234	Anthony Lagoon Beds	-	-	230	2400	1518 ppm	
3115	Brunette 54	22 miles north-north-east of Rockhampton Downs Homestead	685	150	Anthony Lagoon Beds	-	-	120/147	2000	590 ppm	
3116	Brunette 53	16 miles north-north-east of Rockhampton Downs Homestead	705	175	Anthony Lagoon Beds	-	-	158	2800	760 ppm	

APPENDIX B (CONTD)

Reg. No.	Station No. or Name	Position	Elevation in feet	Total Depth in feet	Rock Units	Depth of Aquifers * Main Supply in feet	Depth Standing Water Level in feet	Pump Depth in feet	Supply in g.p.h.	Quality	Remarks
1251	Creswell 6	14 miles west-north-west of Creswell Downs	750	241	Anthony Lagoon Beds	185, 220*	184	-	1450	1251 ppm	
1252	Creswell 7	18.5 miles east of Creswell Downs Homestead	775	242	Anthony Lagoon Beds	211	-	-	-	5042 ppm	
2158	Anthony Lagoon 15	31 miles west of Anthony Lagoon Homestead	725	194	Anthony Lagoon Beds	180, 194	-	184	1800	Suitable for Humans 1273 ppm	
2409	Creswell 12	27 miles east by north of Creswell Downs Homestead	800	333	Anthony Lagoon Beds	298, 305	210	326		545 ppm	
2410	Creswell 11	19.5 miles east-north-east of Creswell Downs Homestead	790	260	Anthony Lagoon Beds	232	225	-	1460	888 ppm	
2411	Creswell 10	17.5 miles north-east of Creswell Downs Homestead	800	302	Anthony Lagoon Beds	235	223	-	1440	906 ppm	
2413	Creswell 8	11 miles east-south-east of Creswell Downs Homestead	775	265	Anthony Lagoon Beds	-	206	-	1200	4083 ppm	
2746	Creswell 14	38 miles east of Creswell Downs Homestead	810	325	Cambrian or Upper Preterozoic	72, 134-325*	52	-	1300	Fair 304 ppm	
2749	Creswell 16	37 miles east of Creswell Downs Homestead	820	179	Cambrian (?)	70, 105-176	70	-	4000	Good	
2750	Creswell 17	24 miles north-east of Creswell Downs Homestead	845	392	Cambrian	298, 370	140	-	-	Fair	
2751	Creswell 18	6.5 miles north of Creswell Downs Homestead	765	288	Cambrian	203, 270	120	-	1000	Fair 3824 ppm	
2752	Creswell Kelly Bore	13 miles north of Creswell Downs Homestead	780	369	Cambrian	201, 328, 369	140	-	1500	Fair 1356 ppm	
3148	Anthony Lagoon 25	36 miles west by north of Anthony Lagoon Homestead	756	270	Anthony Lagoon Beds	198	-	270	1800	-	
RANKEN 1:250,000 SHEET AREA											
83	Avon Downs 5	20 miles north of Avon Downs Homestead	850	334	Camooweal Dolomite	275	-	-	3000	Good 733 ppm	
84	Avon Downs 6	Between 6-mile Creek and Bull Creek	860	304	Camooweal Dolomite	290	-	-	300	494 ppm	
96	Avon Downs 20	Headwaters of Lingaree Creek	880	374	Camooweal Dolomite	-	297	-	-	598 ppm	
97	Avon Downs 21	South-west of Avon Downs No. 20	850	-	Camooweal Dolomite	-	-	-	-	-	Abandoned
215	Barkly Highway 22A	On Six-mile Creek	833	300	Camooweal Dolomite	-	288	-	500	-	Abandoned
347	Avon Downs 8	7 miles north of Lignum W.H.	840	325	Camooweal Dolomite	-	290	315	3000	-	
352	Avon Downs 9	On Six-mile Creek	885	370	Camooweal Dolomite	-	315	-	3000	-	
359	Avon Downs 12 (old)	6 miles north of Avon Downs Homestead	820	290	Camooweal Dolomite	-	263	-	6000	Good	Abandoned; see Reg. No. 3159

APPENDIX B (CONTD)

Reg. No.	Station No. or Name	Position	Elevation in feet	Total Depth in feet	Rock Units	Depth of Aquifers * Main Supply in feet	Depth Standing Water Level in feet	Pump Depth in feet	Supply in g.p.h.	Quality	Remarks
					WALLHALLOW 1:250,000 SHEET AREA						
524	B.S.R. 2	4½ miles west of Turkey Creek	754	208	Anthony Lagoon Beds	180	157	195	1300	Fair for domestic use 471 ppm	
525	B.S.R. 1	16 miles west of Anthony Lagoon Homestead	759	242	Anthony Lagoon Beds	215	156	-	1400	2175 ppm	
598	Anthony Lagoon 3	6 miles west by south of Anthony Lagoon Homestead on Six-mile Creek	730	225	Anthony Lagoon Beds	145-225	178	-	2700	3640 ppm	
599	Anthony Lagoon 4	Headwaters of Lignum Creek	700	398	Anthony Lagoon Beds	208, 381	200	200	1500	3296 ppm	
600	Anthony Lagoon 5	7 miles north-north-west of Anthony Lagoon Homestead	700	331	Anthony Lagoon Beds	170, 289	171	202	1800	Unfit for Humans 3702 ppm	
601	Anthony Lagoon 6	9 miles north-east of Anthony Lagoon Homestead	710	274	Anthony Lagoon Beds	171, 270	-	194	1700	2361 ppm	
605	Anthony Lagoon 2	Anthony Lagoon Homestead	716	225	Anthony Lagoon Beds	162, 200-220	145(?)	-	2500	2702 ppm	
606	Anthony Lagoon 8	25 miles west by north of Anthony Lagoon Homestead	691	309	Anthony Lagoon Beds	190, 297	170	-	2400	Unfit for Humans 3044 ppm	
607	Police Bore-Anthony Lagoon	Anthony Lagoon Police Station	720	212	Anthony Lagoon Beds	168	-	190	1000	Fit for Stock	
952	Walhallow 1	Old Walhallow Ruins on Cattle Creek	840	363	Cambrian?	-	270	-	2800		
960	Walhallow 2 (Collabirrian Creswell Downs)	Headwaters of Cattle Creek	820	412	Cambrian?	327	304	-	3000	Good 525 ppm	
961	Walhallow 3	Eight Mile Creek	870	320	Cambrian?	240, 286-312	240	-	3200	Excellent	
1067	Mallapunyah	Bullock Creek	860	-	Cambrian?	-	250	-	-	827 ppm	
1070	Creswell-Coolibah	6 miles south of Collabirrian, on Anthony Lagoon-Mallapunyah Road.	805	-	Cambrian?	-	-	-	-	905 ppm	
1246	Creswell 1	Creswell Downs Homestead	745	206	Anthony Lagoon Beds	-	-	-	-	3670 ppm	
1247	Creswell 2	11.5 miles east by north of Creswell Downs Homestead	765	238	Anthony Lagoon Beds	210	205	227	1400	4765 ppm	
1248	Creswell 3	11 miles west by south of Creswell Downs Homestead	720	271	Anthony Lagoon Beds	-	-	-	-	4670 ppm	
1249	Creswell 4	6 miles north-west of Creswell Downs Homestead	725	279	Anthony Lagoon Beds	187, 257*	-	-	2200	Fair 3335 ppm	

APPENDIX B (CONTD)

Reg. No.	Station No. or Name	Position	Elevation in feet	Total Depth in feet	Rock Units	Depth of Aquifers * Main Supply in feet	Depth Standing Water Level in feet	Pump Depth in feet	Supply in g.p.h.	Quality	Remarks
2941	Rockhampton 31	8 miles north by west of Frewena	740	182	Wonarah Beds	140, 178-182*	140	-	2800	Fair	
2942	Rockhampton 32	25 miles north of Frewena	700	380	Wonarah Beds	135, 349-363*	135	-	1200	Fair 2920 ppm	
3106	Brunette K7	22 miles north-north-west of Alroy Downs Homestead	690	307	Wonarah Beds (?)	130, 200, 270*	-	200	2800	-	
3108	Brunette K9	26 miles north-west of Alroy Downs Homestead	642	166	Wonarah Beds	105, 157*	-	121	2000	2248 ppm	
3120	Brunette D1	24 miles north of Frewena	685	187	Wonarah Beds (?)	152, 182*	-	-	-	-	Abandoned (see Reg. No. 2579)
3123	Brunette D16	22 miles north-north-east of Alroy Downs Homestead	690	281	Cambrian dolomite	150, 165, 265*	150	-	1500	Fair 4288 ppm	
3138	Alroy 26	9 miles north by east of Alroy Downs Homestead	750	265	Cambrian dolomite	-	-	190	-	Fair 2660 ppm	
3139	Alroy 25	15 miles east of Alroy Downs Homestead	785	233	Wonarah Beds	-	165	203	-	3003 ppm	
3140	Alroy 24	11 miles south-east of Alroy Downs Homestead	785	196	Wonarah Beds	185	178	-	1440	850 ppm	
3141	Alroy 23	20 miles west-north-west of Alroy Downs Homestead	690	176	Cambrian limestone	-	129	150	-	1507 ppm	
3142	Alroy 8A	7 miles south of Alroy Downs Homestead	770	448	Wonarah Beds	172, 420-448*	142	-	2500	Good	
3143	Alroy 13	19 miles west by south of Alroy Downs Homestead	725	167	Cambrian limestone	147, 166*	-	155	-	1060 ppm	
3144	Alroy 16	18 miles north-north-west of Alroy Downs Homestead	730	193	Cambrian limestone	155, 178*	-	165	-	5130 ppm	
3145	Alroy 18A	26 miles north-east of Alroy Downs Homestead	-	350	Cambrian limestone	-	-	-	-	Poor 6774 ppm	Never equipped
3659	Dalmore 12	11 miles east-north-east of Dalmore Downs Homestead	765	330	Wonarah Beds	280	180	200(?)	Good		
3660	Dalmore 14	6 miles north by east of Dalmore Downs Homestead	765	-	Wonarah Beds	-	-	-	-	-	
3661	Dalmore 15	9 miles north-west of Dalmore Downs Homestead	-	289	Wonarah Beds	-	-	-	-	-	
-	Wonarah	Wonarah Repeater Station	800	366	Wonarah Beds	311	177	321	520	Fit for Humans 1097 ppm	

APPENDIX B (CONTD)

Reg. No.	Station No. or Name	Position	Elevation in feet	Total Depth in feet	Rock Units	Depth of Aquifers * Main Supply in feet	Depth Standing Water Level in feet	Pump Depth in feet	Supply in g.p.h.	Quality	Remarks
1236	Dalmore 1	21 miles north of Wonarah	825	550	Wonarah Beds	-	170(?)	200	-	1505 ppm	
1237	Dalmore 2	12 miles north of Wonarah	760	-	Wonarah Beds	-	-	-	-	1698 ppm	
1238	Dalmore 3	20 miles east of Dalmore Downs Homestead	750	272	Wonarah Beds	-	-	-	-	-	
1239	Dalmore 4	9 miles east of Dalmore Downs Homestead	745	-	Wonarah Beds	-	-	-	-	659 ppm	
1240	Dalmore 5	Dalmore Downs Homestead	765	-	Wonarah Beds	-	-	-	-	1305 ppm	
1241	Dalmore 6	18 miles east-north-east of Dalmore Downs Homestead	775	246(?)	Wonarah Beds	-	-	-	-	923 ppm	
1242	Dalmore 7	14 miles north-north-east of Dalmore Downs Homestead	755	230	Wonarah Beds	-	-	-	-	944 ppm	
1749	Dalmore 11	16 miles east by north of Dalmore Downs Homestead	785	230	Wonarah Beds	-	-	-	2500	-	
2190	Alroy 17	16 miles north-north-east of Alroy Downs Homestead	775	235	Cambrian limestone	-	170	187	2000	Unfit for Humans 4574 ppm	
2191	Alroy 18	23 miles north-east of Alroy Downs Homestead	745	212	Cambrian limestone	-	-	-	-	Poor 6785 ppm	Abandoned in 1962
2192	Alroy 19	13 miles south-south-west of Alroy Downs Homestead	750		Wonarah Beds	-	140	-	-	2056 ppm	
2193	Alroy 20	15 miles west-south-west of Alroy Downs Homestead	725	235	Wonarah Beds	-	-	-	-	Good 1496 ppm	
2194	Alroy 21	3 miles east by north from Dookamunda W.H. on Playford River	690	182	Cambrian limestone	-	-	-	-	Fair 1458 ppm	
2195	Alroy 22	8 miles south by east of Buchanan Dam	785	270	Wonarah Beds	-	175	-	-	Unfit for Humans 2224 ppm	
2229	Rockhampton 22	37 miles north-west of Frewena	722	477	Wonarah Beds	-	-	-	-	3369 ppm	
2236	Rockhampton 29	13 miles north by west of Frewena	730	186	Wonarah Beds	-	160	-	-	1857 ppm	
2281	Brunette D11	In Lake Sylvester, 2 miles north of Lignum W.H.	670	206	Wonarah Beds (?)	100, 130, 183*	100	-	1800	4506 ppm	
2579	Brunette D1	24 miles north of Frewena	685	220	Wonarah Beds (?)	161, 200	140	-	3200	Fair 1372 ppm	
2800	S.B.S.R. 7	10 miles north of Frewena	710	190	Wonarah Beds (?)	140	141	1500		1276 ppm	
2940	Rockhampton 30	15 miles west-north-west of Frewena	715	245	Wonarah Beds	142, 217-241*	142	-	2200	437 ppm	

APPENDIX B (CONTD)

Reg. No.	Station No. or Name	Position	Elevation in feet	Total Depth in feet	Rock Units	Depth of Aquifers & Main Supply in feet	Depth Standing Water Level in feet	Pump Depth in feet	Supply in g.p.h.	Quality	Remarks
719	Alroy 1	11 miles east of Alroy Downs Homestead	770	190	Cambrian limestone	150 (?)	150	165	1500	Salty 2526 ppm	
720	Alroy 2	14 miles north-west of Alroy Downs Homestead	750	180	Cambrian limestone	-	148	163	2000	Fair 1888 ppm	
721	Alroy 3	14 miles west of Alroy Downs Homestead	720	190	Wonarah Beds	-	150	165	2000		
722	Alroy 4	16 miles south-east of Alroy Downs Homestead	810	600	Wonarah Beds	-	180	217	1000	Good 1415 ppm	
723	Alroy 5	Alroy Downs Homestead	745	180	Wonarah Beds (?)	-	150	162	2000	Not fit for humans 2317 ppm	
724	Alroy 6	13 miles north of Alroy Downs Homestead, on Brunette Downs Road	740	170	Cambrian limestone	-	140	157	2000	Not fit for Humans 2538 ppm	
725	Alroy 7	12 miles south of Alroy Downs Homestead, on Dalmore Downs Road	770	180	Wonarah Beds	-	150	163	2000	Good 1375 ppm	
726	Alroy 8	5 miles south by west of Alroy Downs Homestead, on Dalmore Downs Road	770	198	Wonarah Beds	148	143	164	2000		Abandoned; Replaced by Reg. No. 3142
727	Alroy 9	24 miles west of Alroy Downs Homestead, on Frewena Road	670	147	Wonarah Beds (?)	-	115	123	2000	Good 1336 ppm	
728	Alroy 10	Desert Creek confluence with Playford River	765	177	Cambrian limestone	140	142	165	2000	Unfit for Humans 4018 ppm	
729	Alroy 11	13 miles south of Buchanan Dam	800	260	Wonarah Beds	180	130	204	2000	Unfit for Humans 1831 ppm	
730	Alroy 12	17 miles east of Frewena	704	267	Wonarah Beds	-	150	240	2000	Unfit for Humans 1274 ppm	
731	Dalmore 13	4 miles south of Mt. Lamb	800	208	Wonarah Beds	-	170	190	2000	1472 ppm	Originally Alroy Downs No.13 +
732	Alroy 14	11 miles north-east of Frewena on Alroy Downs Road	700	160	Wonarah Beds	-	125	130		Fair 992 ppm	
733	Alroy 15	19 miles north-north-east of Frewena	680	144	Wonarah Beds	125	125	135	2000	Unfit for Humans 2801 ppm	
734	S.B.S.R. 3	8 miles west of Desert Creek	800	250	Wonarah Beds	-	180	200	1700	918 ppm	Originally Alroy Downs No. 16+
1212	Brunette Rocky 2	20 miles north by east of Frewena	690	198	Wonarah Beds (?)	-	138	150	-	1417 ppm	

+ Since the transfer of these bores, Alroy Downs Station has drilled replacement bores at other localities viz registered Nos. 3143 (No. 13) and 3144 (No. 16).

APPENDIX B (CONTD)

Reg. No.	Station No. or Name	Position	Elevation in feet	Total Depth in feet	Rock Units	Depth of Aquifers * Main Supply in feet	Depth Standing Water Level in feet	Pump Depth in feet	Supply in g.p.h.	Quality	Remarks
43	Dalmore 10 (Barkly Highway 9A)	2 miles north-west of Barkly Highway-Anthony Lagoon Beef Road Junction	748	254	Wonarah Beds	-	152	-	300	Poor	Not equipped
124	Brunette 34	On southern margin of Lake Sylvester, 11 miles west of Playford River.	655	186	Wonarah Beds (?)	110, 154*	100	150	2000	Good 2488 ppm	
231	Barkly Highway 21A	On Barkly Highway, 25 miles west-north-west of Frewena	815	251	Wonarah Beds	-	217	-	530	-	
285	Rockhampton 7	18 miles north-north-west of Frewena	765	244	Wonarah Beds	-	139/158	-	Good	Good 1899 ppm	
353	Dalmore 8 (Barkly Highway 18A)	On Barkly Highway, 5 miles south-south-west of Dalmore Downs Homestead	750	232	Wonarah Beds	-	-	170	800	860 ppm	
358	Rockhampton 3	8 miles north-west of Frewena	730	196	Wonarah Beds	-	147	-	Good	Good 442 ppm	
364	Barkly Highway 16A	Barkly Highway 9 miles west-north-west of Wonarah	785	231	Wonarah Beds	-	190	-	500	-	Not equipped
379	Barkly Highway 11A	Barkly Highway 13 miles south-west of Frewena	740	199	Wonarah Beds	-	172	-	500	-	Not equipped
395	Rockhampton 4	25 miles north by west of Frewena	775	269	Wonarah Beds	-	147	-	Good	Brackish 3301 ppm	
396	Rockhampton 6	3 miles north of Frewena	700	186	Wonarah Beds	-	141	-	Good	Good 989 ppm	
403	Brunette 24	Near Lake Sylvester, 5 miles west of Playford River	660	245	Wonarah Beds (?)	102, 228*	101	131	2500	Fit for stock 4880 ppm	
414	Rockhampton 14	19 miles north of Frewena	733	149	Wonarah Beds	-	124	132	Good	Brackish 3144 ppm	
496	S.B.S.R. 2	9 miles north of Korringnew swamp	820	456	Wonarah Beds (?)	208	208	233	2800	Good	
498	S.B.S.R. 4	8 miles south by east of Alroy Downs Homestead	780	221	Wonarah Beds (?)	132, 205*	132	154	2400	Good	
499	S.B.S.R. 5	13 miles west by south of Alroy Downs Homestead	720	230	Wonarah Beds (?)	160, 210*	160	189	2400	Good	
500	S.B.S.R. 6	19 miles north-east of Frewena	690	220	Wonarah Beds (?)	126	126	-	2000	980 ppm	
501	S.B.S.R. 7	10 miles north of Frewena	710	198	Wonarah Beds (?)	141, 180*	141	171	1000	Good	Apparently clogged with clay in 1961. Replaced by No. 2800
503	S.B.S.R. 8	17 miles north-west of Frewena	730	328	Wonarah Beds (?)	153, 315*	153	220	2000	Good 1071 ppm	
504	S.B.S.R. 9	31 miles west-north-west of Frewena	735	314	Wonarah Beds (?)	167, 305	167	210	2400	Good 1052 ppm	

APPENDIX B (CONTD)

Reg. No.	Station No. or Name	Position	Elevation in feet	Total Depth in feet	Rock Units	Depth of Aquifers * Main Supply in feet	Depth Standing Water Level in feet	Pump Depth in feet	Supply in g.p.h.	Quality	Remarks
3117	Brunette 52	11 miles east by south of Rockhampton Downs Homestead	720	174	Anthony Lagoon Beds	140	-	158	2800	-	
3118	Brunette 51	Wire Yard W.H. on Creswell Creek, on Brunette Downs-Creswell Road	755	333	Anthony Lagoon Beds	-	-	240	1800	4367 ppm	
3119	Brunette D15	19 miles south of Brunette Downs Homestead on Alroy Downs Road	678	176	Anthony Lagoon Beds	95, 125, 154*	95	175	1200	Fair 3560 ppm	
3121	Brunette D18	14 miles east-south-east of Brunette Downs Homestead	725	270	Cambrian dolomite	180, 250*	180	234(a)	1400	Fair	
3122	Brunette D17	23 miles east of No. 28	700	294	Cambrian dolomite	172, 272*	170	280	1500	Fair 3970 ppm	
3146	Anthony Lagoon 27	On Rocky Creek, near Tarrabool Lake	695	200	Anthony Lagoon Beds	-	-	180	-	-	
3147	Anthony Lagoon 26	10 miles east of Anthony Lagoon Aerodrome	690	255	Anthony Lagoon Beds	-	-	230	-	2308 ppm	
3149	Brunette 16	Headwaters of Corella Creek	755	425	Anthony Lagoon Beds	-	-	260	14,000(?)	2000 ppm	
3163	B.S.R. Bishops (old)	6 miles south-east of Corella Creek	735	261	Anthony Lagoon Beds	205	172	210	1600	Fair	Now abandoned, see No. 2901
3568	Brunette D46	20 miles east-south-east of Brunette Downs Homestead	725	225	Cambrian dolomite	192, 210*	186	-	-	2945 ppm	
3654	Brunette D43	North-western margin of Lake Sylvester	650	-	Anthony Lagoon Beds	-	-	-	-	-	
3655	Brunette D44	Near White W.H. seven miles north of Boree Creek	685	210	Cambrian dolomite	150	137	-	-	5350 ppm	
3656	Brunette D45	2 miles north of Boree Creek	695	206	Cambrian dolomite	157	146	-	-	3104 ppm	
3657	B.S.R. Quarantine	**3 miles south of** Mittiebah Creek			-						
	Brunette D42	4 miles north of Lake De Burgh	687	-	Anthony Lagoon Beds	-	-	-	-	3102 ppm	
					ALROY 1:250,000 SHEET AREA						
29	Dalmore 9 (Barkly Highway 14A)	Barkly Highway, 9 miles south by east of Dalmore Downs Homestead	785	251	Wonarah Beds	-	172	-	-	1420 ppm	
31	Barkly Highway 4A	Barkly Highway, ½ mile east of Wonarah	800	305	Wonarah Beds	-	227	-	300	-	Not equipped
32	Barkly Highway 17A	Barkly Highway 15 miles west-north-west of Frewena	770	172	Wonarah Beds	-	156	-	1140	-	Not equipped
41	Frewena (Barkly Highway 6A)	Barkly Highway	711	188	Wonarah Beds	-	133	-	3600	586 ppm	

(a) Position of pump during test

APPENDIX B (CONTD)

Reg. No.	Station No. or Name	Position	Elevation in feet	Total Depth in feet	Rock Units	Depth of Aquifers ☆ Main Supply in feet	Depth Standing Water Level in feet	Pump Depth in feet	Supply in g.p.h.	Quality	Remarks
392	Avon Downs 10	James River	875	380	Camooweal Dolomite	-	300	-	6000	940 ppm	
495	S.B.S.R. 1	16 miles west by north of Ranken Store	785	336	Camooweal Dolomite	180, 276, 336	180	224	960	Good 1988 ppm	
532	B.S.R.-Alexandria	2 miles south of Alexandria Homestead	795	284	Camooweal Dolomite	175, 278	175	225	1500	Good	
533	B.S.R.-Buchanan	2.5 miles south of Buchanan Creek	840	273	Camooweal Dolomite	226, 255, 272	213	239	1330	Good 374 ppm	
534	B.S.R. Ranken Plain	14 miles north of Ranken Store	860	344	Camooweal Dolomite	225, 258	225	286	1000	Good	
536	B.S.R. Avon	On Bull Creek	815	290	Camooweal Dolomite	-	258	-	1020	Good 682 ppm	
537	B.S.R. Rocklands West	Blue-bush Creek	810	372	Camooweal Dolomite	-	240	297	1550	Fair 1289 ppm	
542	B.S.R. O'Reillys	1.5 miles north of Barkly Highway	825	-	Camooweal Dolomite	-	-	270	1200	Fair 1259 ppm	
545	B.S.R. Rocklands East	Cattle Creek	860	323	Camooweal Dolomite	-	270	-	1500	Good 1227 ppm	
735	Alexandria 1	16 miles south-east of Alexandria Homestead	815	1760	Burton Beds, Camooweal Dolomite; Mittiebah Sandstone	238	233	232/275	3500	Useable 342 ppm	
736	Alexandria 2	South-west of Alexandria Homestead. Not located	-	450	-	166	166	253	400	Useable	Abandoned
737	Alexandria 3	4 miles north of Buchanan Creek	850	344	Burton Beds	-	241	284	3000	Useable 636 ppm	
738	Alexandria 4	Playford River	795	360	Burton Beds	-	202	267	3000	Useable 517 ppm	
740	Gallipoli 6	8 miles east by south of Gallipoli Homestead	879	402	Camooweal Dolomite	-	346	367	-	-	
742	Alexandria 7	4 miles south of junction of Barkly Highway and main access road to B.S.R.	80 5	313	Camooweal Dolomite	250, 313	223	239	3000	-	
743	Alexandria 8	On Lorne Creek; not located	-	408	-	-	-	-	-	-	No supply
744	Alexandria 9	Near Ranken Store	805	306	Camooweal Dolomite	243	233	243	3000	Good 1100 ppm	
745	Alexandria 10	10 miles north-east of Ranken Store	815	366	Camooweal Dolomite	255, 320, 345☆	254	254	3000	Good	
746	Alexandria 11	Borodo Creek	835	308	Camooweal Dolomite	255	237	258	3000	Good	
747	Alexandria 12	Alexandria Homestead	815	451	Burton Beds	445	255	249	3000	Good 370 ppm	
750	Alexandria 15	Near Alexandria Homestead	-	130	Burton Beds	-	-	-	-	-	Not completed

APPENDIX B (CONTD)

Reg. No.	Station No. or Name	Position	Elevation in feet	Total Depth in feet	Rock Units	Depth of Aquifers * Main Supply in feet	Depth Standing Water Level in feet	Pump Depth in feet	Supply in g.p.h.	Quality	Remarks
751	Alexandria 16	South-west of Alexandria Homestead	805	278	Burton Beds	205, 240, 260*	205	225	3000	Useable 294 ppm	
752	Alexandria 17	On Ranken River, 12 miles downstream from Ranken Store	805	841	Ranken Limestone	745, 835*	-	395/700	3000	Useable 2520 ppm	
753	Alexandria 18	3.5 miles south-west of Junction of Ranken River and Lorne Creek	780	437	Ranken Limestone	260-435	225	273	3000	Good	
754	Alexandria 19	East of Six-mile Creek	815	263	Camooweal Dolomite	243?	243	-	3000	Good	Abandoned. See Reg. No. 2487
755	Alexandria 20	9 miles east of Lulu W.H., on Gallipoli Road	890	305/325	Camooweal Dolomite	285/296	285/296	300/320	2000	Good	Redrilled in 1961
756	Alexandria 21	4 miles west of D'arcy Grave on Gallipoli Road	908	358	Camooweal Dolomite	290, 320*	280	300	2400	Good 875 ppm	
757	Alexandria 22	12.5 miles east by north of Ranken Store	830	501	Camooweal Dolomite	278, 379*	268	-	1200	Good	Abandoned
758	Alexandria 23	14.5 miles east by north of Ranken Store	845	603	Camooweal Dolomite	100, 500, 600*	280	-	2250	460 ppm	
932	B.S.R.- Ranken Dip	Ranken Dip	797	309	Camooweal Dolomite	-	256	280	-	Good 2094 ppm	
940	Rocklands 6	Cattle Creek	855	526	Camooweal Dolomite	278, 285*	-	-	1600	-	Abandoned
941	Rocklands 10	Georgina River	830	300	Camooweal Dolomite	255	245	-	1600	Fair 534 ppm	
942	Rocklands 11	Kiama Creek	825	353	Camooweal Dolomite	260, 286, 314, 343*	240	-	1600	Good	
944	Rocklands 13	Happy Creek	835	355	Camooweal Dolomite	265, 355	-	-	Good	Good 548 ppm	
945	Rocklands 14	Georgina River	850	400	Camooweal Dolomite	-	-	-	700	-	Abandoned
946	Rocklands 15	Middle Branch	845	339	Camooweal Dolomite	-	270	-	1600	-	Abandoned
947	Rocklands 16	McKay Creek	870	338	Camooweal Dolomite	-	280	-	1600	-	Abandoned
948	Rocklands 17	Scrubby Creek	855	308	Camooweal Dolomite	-	280	300	1600	Good	
949	Rocklands 19	Mikado Creek	875	420	Camooweal Dolomite	280	-	318	1600	558 ppm	
950	Rocklands 23	7 miles south-west of Dariel Gate on border fence	810	360	Camooweal Dolomite	305, 325*	280	-	1800	-	
951	Avon Downs 11	6.5 miles north of Avon Downs No. 10 (Reg. No. 392)	870	344	Camooweal Dolomite	-	292	318	Poor	Fair 595 ppm	
999	Rocklands 24	Middle Branch	880	350	Camooweal Dolomite	-	315	-	-	-	
1000	Rocklands 25	West of Rocklands No. 24	870	229	Camooweal Dolomite						Not completed
1142	Alexandria 32	Homestead	815	446	Burton Beds	223, 253	185	280	-	Good	
1143	Alexandria 29	On South Barkly Stock Route	80 5	389	Camooweal Dolomite	227, 250-280, 350-385	200	301	2100	Good	

APPENDIX B (CONTD)

Reg. No.	Station No. or Name	Position	Elevation in feet	Total Depth in feet	Rock Units	Depth of Aquifers * Main Supply in feet	Depth Standing Water Level in feet	Pump Depth in feet	Supply in g.p.h.	Quality	Remarks
1144	Alexandria 28	Not located	-	-	-	-	-	-	-	-	Probably 1st attempt at Alexandria No. 41
1148	Alexandria 41	4.5 miles south of Bell W.H. on Lorne Creek	775	389	Ranken Limestone or Camooweal Dolomite	-	221	247	2700	Good 1238 ppm	
1149	Alexandria 27	Playford River	770	419	Burton Beds	178, 250, 410*	150	370	Good	Good	
1150	Alexandria 24	Cigarette Hole Creek	840	382	Camooweal Dolomite	275, 352, 382*	268	366	-	482 ppm	
1151	Alexandria 25	White W.H.	830	411	Burton Beds or Camooweal Dolomite	340, 393*	258	393	-	384 ppm	
1152	Alexandria 26	2.5 miles west of Lulu W.H., on Gallipoli Road	880	402	Camooweal Dolomite	291, 334, 382, 480	275	365	Good	Useable 427 ppm	
1153	Gallipoli 1	Homestead	900	367	Camooweal Dolomite	-	346	367	2400	Good 520 ppm	
1154	Gallipoli 7	8 miles north of Gallipoli Homestead	885	400	Camooweal Dolomite	-	240	-	Good	Good 364 ppm	Put down as Herbert Vale No. 7
1155	Gallipoli 5	7 miles south-east of Gallipoli Homestead	885	402	Camooweal Dolomite	-	260	-	Good	Good 570 ppm	Put down as Herbert Vale No. 5
1156	Alexandria 31	10.5 miles south-west of Gallipoli Homestead	920	930	Camooweal Dolomite	315, 326	305	317	Good	Good 401 ppm	
2486	Alexandria 49	10 miles west by north of Alexandria Homestead	765	246	Burton Beds	200	185	-	2000		
2487	Alexandria 19 (New)	East of Six-Mile Creek	815	268	Camooweal Dolomite	232	210	-	-	Fair	
2769	Alexandria 51	25 miles south by west of Alexandria Homestead	775	242	Burton Beds (?)	180	170	-	2000	2090 ppm	
3124	Alexandria 30	10 miles south-west of Gallipoli Homestead	920	149	Camooweal Dolomite	-	-	-	-	-	1st attempt at No. 31 (Reg. No. 1156)
3125	Alexandria 50	19 miles south-south-west of Alexandria Homestead	785	204	Burton Beds (?)	165	160	-	2000	Good 620 ppm	
3126	Alexandria 36	7 miles north of Cigarette Hole Creek	880	388	Camooweal Dolomite	310, 380*	285	325	Good	Good 455 ppm	
3131	Alexandria 42	Oolgoolgarri Swamp	820	220	Camooweal Dolomite(?)	197, 210*	190	-	2040	Good	
3133	Alexandria 44	Buchanan Creek	855	310	Burton Beds	300	-	267	1800	Good 409 ppm	
3135	Alexandria 46	North by west of Weaner W.H.	885	350	Camooweal Dolomite	330	-	-	1800	Good 472 ppm	
3136	Alexandria 47	3.5 miles north-west of Homestead	825	323	Burton Beds	222, 304*	-	285	2040	Good 31 ppm	

APPENDIX B (CON TD)

Reg. No.	Station No. or Name	Position	Elevation in feet	Total Depth in feet	Rock Units	Depth of Aquifers & Main Supply in feet	Depth Standing Water Level in feet	Pump Depth in feet	Supply in g.p.h.	Quality	Remarks
3137	Alexandria 48	16 miles south by east of Homestead	840	260	Burton Beds (?)	222-250	212	250	2700	Good 333 ppm	
3156	Rocklands 27	Cattle Creek	880	381	Camooweal Dolomite	290, 335, 370	281	-	2400	Good 568 ppm	
3157	Rocklands 28	Georgina River	845	415	Camooweal Dolomite	347, 360, 397	-	-	1800	406 ppm	
3158	Herbert Vale 4	10 miles north-east of Gallipoli Homestead	849	395	Camooweal Dolomite	-	-	-	-	-	
3159	Avon Downs 12 (new)	Between James River and Bull Creek	820	336	Camooweal Dolomite	-	263	270	-	528 ppm	
3162	Avon Downs 26	Six-mile Creek	835	375	Camooweal Dolomite	-	250	-	-	1132 ppm	
3163	B.S.R.-Wilfred	Twelve-Mile Creek	785	338	Camooweal Dolomite	-	221	250	1220	Fair 1408 ppm	

MOUNT DRUMMOND 1:250,000 SHEET AREA

Reg. No.	Station No. or Name	Position	Elevation in feet	Total Depth in feet	Rock Units	Depth of Aquifers & Main Supply in feet	Depth Standing Water Level in feet	Pump Depth in feet	Supply in g.p.h.	Quality	Remarks
531	B.S.R.-Connells	Connells Lagoon	776	288	Burton Beds	225, 258	225	256	1800	Good 343 ppm	
748	Alexandria 13	On Eastern Creek	860	383	Burton Beds	264	234	272	3000	452 ppm	
749	Alexandria 14	3.5 miles north of Tobacco W.H. on Playford River	895	665	Burton Beds/Camooweal Dolomite	632	250	268/403	3500	415 ppm	
3127	Alexandria 37	3 miles north-north-east of Iris W.H. on Playford River	855	340	Burton Beds	160, 320	-	285	-	-	
3128	Alexandria 38	3 miles north-east of Bull W.H. on Corporal Creek	908	495	Camooweal Dolomite	280, 490-495	-	380	2400	441 ppm	
3129	Alexandria 39	5.5 miles west of Bull W.H. on Corporal Creek	908	400	Camooweal Dolomite	268, 395	268	387	2500	373 ppm	
3130	Alexandria 40	14 miles north of Connells	770	268	Burton Beds (?)	213-268	213	255	-	-	Not working in 1962
3134	Alexandria 45	5 miles south of Connells	760	253	Burton Beds	233	-	-	1800	-	
3658	B.S.R. New Quarantine Bore	8 miles north of Connells	755	400	Burton Beds (?)	215	210	-	Poor	-	Abandoned

AVON DOWNS 1:250,000 SHEET AREA

Reg. No.	Station No. or Name	Position	Elevation in feet	Total Depth in feet	Rock Units	Depth of Aquifers & Main Supply in feet	Depth Standing Water Level in feet	Pump Depth in feet	Supply in g.p.h.	Quality	Remarks
75	Lake Nash 22	Lake Nash Homestead	578	216	Camooweal Dolomite?	-	63	190	Good	Good	
91	Avon Downs Old 15	7 miles south of Avon Downs Homestead	740	203	Camooweal Dolomite(?)	-	183	-	-	-	Abandoned; see Reg. No. 3160
92	Avon Downs 17	On eastern side of Blue-bush swamp, 5 miles south of Rankon River	668	160	Camooweal Dolomite (?)	-	120	-	1700	1218 ppm	New Austral Downs No. 17 on Burramurra Block
93	Avon Downs 16	29 miles south of Avon Downs Homestead	685	218	Camooweal Dolomite (?)	-	130	-	1700	-	

APPENDIX B (CONTD)

Reg. No.	Station No. or Name	Position	Elevation in feet	Total Depth in feet	Rock Units	Depth of Aquifers & Main Supply in feet	Depth Standing Water Level in feet	Pump Depth in feet	Supply in g.p.h.	Quality	Remarks
94	Avon Downs 18	17 miles west-south-west of Austral Downs Homestead	690	325	Camooweal Dolomite(?)	-	130/150	-	1250	-	Now Austral Downs No. 18 on Burramurra Block
95	Avon Downs - 19	At Burramurra Homestead	685	350	Camooweal Dolomite(?)	-	150	-	1750	-	Now Austral Downs No. 19 on Burramurra Block
98	Avon Downs 22	6 miles south-east of Avon Downs Homestead	790	276	Camooweal Dolomite	-	238	-	1750	878 ppm	Abandoned
206	Barkly Highway 7A	9 miles west by south of Soudan Homestead	822	196	Wonarah Beds	-	156	-	1600	-	Not working
214	Avon Downs 17-mile well	15 miles south by east of Avon Downs Homestead	743	207	Camooweal Dolomite	-	200	-	Good	-	Abandoned
318	Avon Downs 13	3 miles south-east of Avon Downs Homestead	765	230	Camooweal Dolomite	-	218	-	Poor	-	Abandoned
331	Avon Downs 14	20 miles south by east of Avon Downs Homestead	741	221	Camooweal Dolomite	-	176	-	1300	1490 ppm	
340	Avon Downs 3	12 miles south-east of Avon Downs Homestead	750	228	Camooweal Dolomite	-	202	218	-	1490 ppm	
346	Avon Downs 2	Not located.	770(?)	246	-	-	230	-	-	-	Abandoned
366	Avon Downs 1	8 miles east of Avon Downs Homestead	765	259	Camooweal Dolomite	-	235	-	1750	712 ppm	
369	Avon Downs 4	2 miles north-west of Homestead	-	226	Camooweal Dolomite	-	211	-	1720	-	Abandoned
384	Avon Downs 23	Avon Downs Homestead	679	228	Camooweal Dolomite(?)	-	216	-	1750	587 ppm	
739	Alexandria 5	5 miles east of Soudan Homestead	775	317	Camooweal Dolomite(?)	-	215	227	3000	-	
741	Alexandria 6	Ranken River 16 miles downstream from Soudan Homestead	710	608	Camooweal Dolomite(?)	-	-	-	-	-	No Supply
769	Austral Downs 4-mile Bore	5 miles west-north-west of Austral Downs Homestead	666	168	Camooweal Dolomite	-	146	-	-	-	
770	Austral Downs Goat Hole	Near confluence of Western Creek and Georgina River	796	246	Camooweal Dolomite	-	-	180	2000	-	
771	Austral Downs Shakespeare 1	14 miles north by west of Austral Downs Homestead	688	254	Camooweal Dolomite	140	-	-	500	-	Never equipped
772	Austral Downs Shakespeare 2	14 miles north by west of Austral Downs Homestead	688	184	Camooweal Dolomite	143-156; 179-184	141	-	2000	-	

APPENDIX B (CONTD)

Reg. No.	Station No. or Name	Position	Elevation in feet	Total Depth in feet	Rock Units	Depth of Aquifers * Main Supply in feet	Depth Standing Water Level in feet	Pump Depth in feet	Supply in g.p.h.	Quality	Remarks
773	Austral Downs New Year	10 miles north-north-east of Austral Downs Homestead	790	220	Camooweal Dolomite	-	-	200	3000	-	
775	Austral Downs Yellow Hole 1	Yellow W.H. on Blue-bush Creek	680	219	Camooweal Dolomite	142, 161-210	145	-	2000	-	Abandoned, silted up
776	Austral Downs Yellow Hole 2	Yellow W.H. on Blue-bush Creek	680	173	Camooweal Dolomite	137, 173*	142	-	2000	-	
777	Austral Downs Bluebush	12 miles east-south-east of Austral Downs Homestead on Blue-bush Creek	640	179	Camooweal Dolomite	131, 167	124	124	2000	-	
778	Austral Downs Coolibah	12 miles south of Austral Downs Homestead	660	380	Camooweal Dolomite	116-147, 332	147	185	2000	-	
779/996	Austral Downs Poison Bore	19 miles south-east of Austral Downs Homestead	630	278	Camooweal Dolomite	-	113	141	-	-	Bore was redrilled. Not equipped
939	Rocklands 4	Western Creek	845	266	Camooweal Dolomite	238	-	238	1300	-	
943	Rocklands 12	Between Happy Creek and Shakespeare Creek	763	298	Camooweal Dolomite	254	-	245	1600	Good	
994	Avon Downs 24	27 miles south-south-east of Avon Downs Homestead	703	315	Camooweal Dolomite	-	145	-	-	1604 ppm	
995	Austral Downs Top Bore 1	23 miles north of Austral Downs Homestead	722	227	Camooweal Dolomite	193	-	-	-	-	Abandoned, tools jammed
1146	Alexandria 34	On Six-mile Creek	760	295	Camooweal Dolomite(?)	-	210	250	2500	-	Abandoned(?)
1147	Alexandria 35	23 miles south-south-east of Soudan Homestead	720	397	Wonarah Beds (?)	300, 325	190	317	-	-	
1185	Austral Downs Goose Hole	9 miles north by west of Austral Downs Homestead	685	190	Camooweal Dolomite	-	-	150	-	-	
1871	Soudan Homestead	Soudan Homestead	738	-	Ranken Limestone(?)	-	208	-	-	1150 ppm	
1906	Avon Downs Police Bore	James River on Barkly Highway	780	231	Camooweal Dolomite	203	193	-	900	Good 1230 ppm	Not equipped
2139	Austral Downs 16	22 miles south-south-west of Austral Downs Homestead	670	-	Camooweal Dolomite	-	-	-	-	-	On Burramurra Block
2140	Austral Downs Mathieson 15	South side of Blue-bush Swamp	680	154	Camooweal Dolomite (?)	-	-	-	-	-	On Burramurra Block
2141	Austral Downs Eldershaw 20	6 miles west-north-west of Burramurra Homestead	-	168	Wonarah Beds (?)	-	-	-	-	-	On Burramurra Block

APPENDIX B (CONTD)

Reg. No.	Station No. or Name	Position	Elevation in feet	Total Depth in feet	Rock Units	Depth of Aquifers & Main Supply in feet	Depth Standing Water Level in feet	Pump Depth in feet	Supply in g.p.h.	Quality	Remarks
2488	Alexandria 34	On Six-mile Creek	760	-	Camooweal Dolomite(?)	-	-	-	-	-	1st attempt at Reg. No. 1146(?)
2489	Alexandria 7B	9 miles west by north of Soudan Homestead	820	335	Wonarah Beds(?)	240	-	-	Poor	-	Abandoned
3132	Alexandria 43	-	-	-	-	-	-	-	-	-	May be identical to Reg. No. 1871
3160	Avon Downs New 15	9 miles south of Avon Downs Homestead	745	306	Camooweal Dolomite	-	191	-	-	-	
3161	Avon Downs 25		-	623	-	-	-	-	-	720	Abandoned (?)
3178	Austral Downs 21	5 miles north of Burramurra Homestead	700		Wonarah Beds (?)	-	-	-	-	-	
3662	Austral Downs New Top	22 miles north of Austral Downs Homestead	700	212	Camooweal Dolomite	-	173	208	-	800	
3663	Austral Downs 10 New	10 miles south-east of Austral Downs Homestead	640		Camooweal Dolomite	-	-	-	-	-	
3664	Austral Downs 22	17 miles north-east of Austral Downs Homestead	795	-	Camooweal Dolomite	-	-	-	-	-	

APPENDIX C

BORE WATER ANALYSES - BARKLY TABLELAND
(in milligrams/litre)

BRUNETTE DOWNS 1:250,000 SHEET AREA

Reg. No.	Ca	Mg	Na	K	Cl	SO_4	HCO_3	CO_3	F	SiO_2	NO_3	NO_2	PO_4	Mn	Fe	Al	B	Pb	Sr	Li	S.C.	pH	T.D.S.	YEAR	LABORATORY
112	292	197	1030	50	1510	1330	370	x	0.8	20	2.2	-	-	-	x0.1	x0.2	1.5	-	3	-	6480	7.0	4600	1962	B.M.R.
115	77.5	25.5	56.5	22	69.7	52.3	361	x	1.3	55.3	11.2	0.025	x0.01	x0.03	0.02	x0.02	0.25	x0.01	2.0	x0.05	817	7.45	540	1962	A.M.D.L.
116	244	142	533	88.5	1027	701	265	x	2.75	42.7	42.4	0.025	x0.01	x0.03	x0.01	x0.02	0.93	x0.01	6.5	0.08	4424	7.45	2869	1962	A.M.D.L.
117	230	128	561	24.0	690	1160	222	x	3.55	21	17.5	x0.001	x0.01	x0.02	x0.01	x0.02	0.91	x0.01	8.9	0.17	4253	7.75	3012	1962	A.M.D.L.
118	164	109	500	57	850	387	474	x	1	15	7.5	-	-	-	x0.1	x0.2	x0.5	-	2.4	-	3400	6.8	2340	1962	B.M.R.
119	173	132	576	31.5	998	461	504	x	2.8	18.6	2.4	0.008	x0.01	x0.03	x0.01	0.05	0.79	x0.01	3.0	0.09	4245	7.45	2672	1962	A.M.D.L.
123	59.5	26.0	251	36	160	199	497	x	4.45	48.4	9.2	0.07	0.01	x0.03	0.015	0.04	2.55	x0.01	2.6	x0.05	1604	7.6	1018	1962	A.M.D.L.
317	52.5	25.5	555	40.5	427.5	493.5	431	x	4.3	38.5	-	-	-	-	-	-	-	-	-	-	2950	7.55	1851	1962	A.M.D.L.
360	140	80	885	46	870	1160	314	x	3	10	13.3	-	-	-	x0.1	x0.2	1.5	-	2.9	-	4500	7.1	3240	1962	B.M.R.
394	43	61	412	38	510	494	229	24	0.86	-	7	-	-	-	-	-	-	-	-	-	-	-	1819	1956	A.I.B.
398	139.5	64.0	630	29.5	686.5	791	288	x	3.2	40.0	-	-	-	-	-	-	-	-	-	-	3920	7.45	2582	1962	A.M.D.L.
405	528	132.2	220	21	289.5	1757	159.1	x	4.9	22.4	-	-	-	-	-	-	-	-	-	-	3639	7.3	3148	1962	A.M.D.L.
413	166.4	80.5	298	23	458.5	397.5	342.8	x	1.7	49.3	-	-	-	-	-	-	-	-	-	-	2644	7.3	1688	1962	A.M.D.L.
415	439.8	103.2	267	21	364.5	1434.9	153	x	4.6	23.0	-	-	-	-	-	-	-	-	-	-	3442	7.15	2746	1962	A.M.D.L.
527	175.7	101.4	676	78	884.8	800.4	306	x	3.8	21.2	-	-	-	-	-	-	-	-	-	-	4402	7.25	2858	1962	A.M.D.L.
528	74.7	45.1	157	13.5	266	174	213	x	2.0	16.5	0.75	x0.001	x0.01	x0.03	x0.01	0.04	0.23	x0.01	0.9	x0.05	1491	7.6	858	1962	A.M.D.L.
530	216	146	760	44	1246	834	312	x	2.85	20.5	-	-	-	-	-	-	-	-	-	-	5310	7.25	3500	1962	A.M.D.L.
546	194	86.2	260	14.5	448	539	307	x	3.8	17.3	0.25	x0.001	x0.01	x0.02	x0.01	0.06	0.44	x0.01	9.9	0.25	2639	7.85	1738	1962	A.M.D.L.
602	375	127	206	15.0	621	914	197	x	3.65	18.3	0.5	x0.001	x0.01	0.02	0.02	x0.02	0.52	x0.01	7.3	0.40	3406	7.7	2410	1962	A.M.D.L.
603	56	34	184	32	80	235	447	x	2	10	8.9	-	-	-	x0.1	x0.2	0.5	-	1.7	-	1170	7.1	850	1962	B.M.R.
604	76.6	51.5	27.5	11.5	18.3	16.5	539	x	0.5	54.5	0.6	0.003	x0.01	x0.02	0.15	0.02	0.12	x0.01	0.6	x0.05	812	7.6	504	1962	A.M.D.L.
761	106.5	68.5	311	23.5	494	333	254	x	2.9	19	-	-	-	-	-	-	-	-	-	-	2510	7.5	1491	1962	A.M.D.L.
762	274.2	152.4	769	69	1243.2	1046	266.2	x	4.1	22.4	-	-	-	-	-	-	-	-	-	-	5594	7.2	3779	1962	A.M.D.L.
795	156	90	830	52	800	1120	421	x	3	25	8.9	-	-	-	x0.1	x0.2	2	-	4.1	-	4200	7.0	3220	1962	B.M.R.
934	126	67.1	370	35	480.8	417.7	388.7	x	3.4	22.2	-	-	-	-	-	-	-	-	-	-	2790	7.35	1718	1962	A.M.D.L.
935	317.1	221.5	884	81	15449	1275.2	238.7	x	4.6	21.5	-	-	-	-	-	-	-	-	-	-	6643	7.25	4480	1962	A.M.D.L.
1180	192	104	308	10	580	547	260	x	3	10	8.9	-	-	-	x0.1	x0.2	x0.5	-	5	-	2910	7.1	2010	1962	B.M.R.
1181	469	148	515	20	760	1660	160	x	3	20	x2.0	--	-	-	x0.1	x0.2	1	-	8	-	4200	7.0	3880	1962	B.M.R.

APPENDIX C - SHEET 2

Reg. No.	Ca	Mg	Na	K	Cl	SO_4	HCO_3	CO_3	F	SiO_2	NO_3	NO_2	PC_4	Mn	Fe	Al	B	Pb	Sr	Li	S.C.	pH	T.D.S.	YEAR	LABORATORY
1182	71.5	33.6	94.5	31.5	71.8	120	421	x	1.9	56.1	9.8	0.01	x0.01	x0.02	x0.01	x0.02	0.48	x0.01	1.6	x0.05	961	7.8	670	1962	A.M.D.L.
1183	252	126	780	23	1120	1010	240	x	1	25	13.3	-	-	-	x0.1	x0.2	1	-	1.8	-	4500	6.9	3360	1962	B.M.R.
1183	156	82	398	26	553	441	393	x	2.5	-	11	-	-	-	-	-	-	-	-	-	-	-	2062	1957	A.I.B.
1211	198.9	131.4	646	45	1093.4	637.8	342.7	x	2.9	17	-	-	-	-	-	-	-	-	-	-	4679	7.3	2964	1962	A.M.D.L.
1213	236	139	786	41.3	1200	977.5	284.5	x	2.9	20.2	-	-	-	-	-	-	-	-	-	-	5410	7.2	3566	1962	A.M.D.L.
1214	266	167	486	30.5	934	730	443	x	2.55	30.1	2.3	x0.001	0.01	x0.03	0.01	x0.02	0.63	x0.01	2.8	0.08	4303	7.4	2901	1962	A.M.D.L.
1215	252.6	178.9	926	59	1575.3	938.2	348.8	x	3.65	15.8	-	-	-	-	-	-	-	-	-	-	6423	7.25	4217	1962	A.M.D.L.
1216	170.2	144.3	676	62.5	1177.6	546.1	425.3	x	4.74	23.6	-	-	-	-	-	-	-	-	-	-	4882	7.35	3019	1962	A.M.D.L.
1217	226	166	812	67.5	1387	773.0	410	x	3.4	16.5	-	-	-	-	-	-	-	-	-	-	5709	7.2	3726	1962	A.M.D.L.
1218	135.7	110	471	49	759.5	391.7	459	x	2.8	18.5	-	-	-	-	-	-	-	-	-	-	3583	7.25	2163	1962	A.M.D.L.
1219	224	156	1230	60	1720	1160	325	x	4	10	x2.0	-	-	-	x0.1	x0.2	2	-	3.5	-	5490	7.0	5720	1962	B.M.R.
1220	255	197	1260	63	2030	1095	266	x	4	15	2.2	-	-	-	x0.1	x0.2	1.5	-	6	-	6440	6.9	4870	1962	B.M.R.
1221	96.5	55.6	128.0	11.1	230.6	144.8	324.4	x	2.49	22.1	-	-	-	-	-	-	-	-	-	-	1475	7.3	840	1962	A.M.D.L.
1222	254.4	161.8	846	47.5	1352.8	1019.3	315.2	x	6.80	20.1	-	-	-	-	-	-	-	-	-	-	5825	7.2	3843	1962	A.M.D.L.
1223	267.5	200.8	1193	71	1941.8	1070.3	376.4	x	4.3	18.1	-	-	-	-	-	-	-	-	-	-	7799	7.15	5079	1962	A.M.D.L.
1225	276.6	162	865	47	1349.4	1142.3	281.6	x	2.9	19.3	-	-	-	-	-	-	-	-	-	-	5982	7.2	4078	1962	A.M.D.L.
1227	458.4	241.9	951	58	1583.7	1752.6	272.4	x	2.8	27.1	-	-	-	-	-	-	-	-	-	-	7203	7.15	5274	1962	A.M.D.L.
1228	173.4	124.4	562	55	967.9	467.9	471.2	x	2.7	17.4	-	-	-	-	-	-	-	-	-	-	4310	7.1	2620	1962	A.M.D.L.
1229	528.6	356.7	1410	55.5	2300	2428.3	260.1	x	12.1	20.4	-	-	-	-	-	-	-	-	-	-	9903	6.95	7212	1962	A.M.D.L.
1230	455.2	315.5	1352	66.5	2118	2028.3	483.5	x	7.51	21.5	-	-	-	-	-	-	-	-	-	-	9003	6.95	6589	1962	A.M.D.L.
1250	295.1	163.6	856	46	1319.1	1192.5	275.4	x	3.3	21.7	-	-	-	-	-	-	-	-	-	-	6033	7.35	4090	1962	A.M.D.L.
1757	372	208	840	37	1345	1305	178	x	3.0	-	2	-	-	-	-	-	-	-	-	-	-	-	4290	1958	A.I.B.

APPENDIX C - SHEET 3

Reg. No.	Ca	Mg	Na	K	Cl	SO_4	HCO_3	CO_3	F	SiO_2	NO_3	NO_2	PO_4	Mn	Fe	Al	B	Pb	Sr	Li	S.C.	pH	T.D.S.	YEAR	LABORATORY
1990	334.4	173	765	36	1174.4	1311.9	275.4	x	2.55	20	-	-	-	-	-	-	-	-	-	-	5599	7.2	4010	1962	A.M.D.L.
1993	156	78	155	10	265	353	405	x	0.4	65	x2.0	-	-	-	x0.1	x0.2	x0.5	-	1	-	1930	6.9	1250	1962	B.M.R.
1995	361	175	580	20	1020	1270	210	x	0.2	40	x2.0	-	-	-	x0.1	x0.2	x0.5	-	1	-	4760	6.9	3710	1962	B.M.R.
1996	308	160	640	20	1010	1225	213	x	0.2	40	x2.0	-	-	-	x0.1	x0.2	0.5	-	2	-	4460	7.0	3530	1962	B.M.R.
1998	382	209	1550	62.5	2058	2139	243	x	4.15	15.9	1.4	0.001	x0.01	x0.02	x0.01	0.06	2.77	x0.01	9.3	0.18	9215	7.7	6708	1962	A.M.D.L.
2157	437	131	644	10	830	1670	190	x	2.0	20	x2.0	-	-	-	x0.1	x0.2	1.5	-	5	-	4760	7.0	3990	1962	B.M.R.
2159	52	29	294	20	250	220	389	x	2.0	20	8.9	-	-	-	x0.1	x0.2	1.5	-	x1.0	-	1780	7.4	1170	1962	B.M.R.
2160	68	22	133	15	75	152	373	x	1.0	10	13.3	-	-	-	x0.1	x0.2	x0.5	-	1.1	-	850	7.1	630	1962	B.M.R.
2161	34.7	21.7	146	14.3	71.7	118.1	342.7	x	2.63	21.7	-	-	-	-	-	-	-	-	-	-	981.9	7.6	602	1962	A.M.D.L.
2162	204	106	398	20	620	720	240	x	3.0	20	8.9	-	-	-	x0.1	x0.2	0.5	-	4	-	3400	7.1	2340	1962	B.M.R.
2163	54	37	224	30	160	165	527	x	2.0	25	13.3	-	-	-	x0.1	x0.2	1.0	-	x1.0	-	1490	7.2	1060	1962	B.M.R.
2222	137.8	75.9	226.5	22.2	333.1	283.9	468	x	1.97	40.7	-	-	-	-	-	-	-	-	-	-	2180	7.1	1376	1962	A.M.D.L.
2223	151.9	63.7	260	24	337.3	418.5	345.8	x	2.3	48.5	-	-	-	-	-	-	-	-	-	-	2322	7.3	1506	1962	A.M.D.L.
2224	64	30	327	23	220	366	392	x	3.1	41	-	-	-	-	-	-	-	-	-	-	2010	7.4	1263	1962	A.M.D.L.
2225	294.2	118.8	979	70	993.8	1573.6	351.9	x	5.2	32.9	-	-	-	-	-	-	-	-	-	-	5834	7.05	4230	1962	A.M.D.L.
2226	220.9	90.8	937	52	783.8	1527.1	330.5	x	5.2	23.9	-	-	-	-	-	-	-	-	-	-	5229	7.35	3814	1962	A.M.D.L.
2227	61.5	28	328	51.5	178	459	398	x	4.3	29.5	-	-	-	-	-	-	-	-	-	-	2100	7.45	1353	1962	A.M.D.L.
2228	282.5	159.5	1160	36.0	1156	2058	217	x	5.55	15.0	-	-	-	-	-	-	-	-	-	-	6850	7.35	5093	1962	A.M.D.L.
2232	181.5	77	569	64.5	339.5	1324	294	x	4.75	26.5	-	-	-	-	-	-	-	-	-	-	3700	7.25	2762	1962	A.M.D.L.
2233	297	122	885	55.5	780.5	1944	190	x	5.29	14.5	-	-	-	-	-	-	-	-	-	-	5520	7.35	4250	1962	A.M.D.L.
2234	563	165.5	89.5	15	164	1856	119	x	4.75	22.2	-	-	-	-	-	-	-	-	-	-	3254	7.2	3078	1962	A.M.D.L.
2235	623	162.5	217	18.5	337.8	2027	129	x	5.7	15.8	-	-	-	-	-	-	-	-	-	-	3960	7.1	3532	1962	A.M.D.L.
2280	535	325	2790	70	3350	3485	285	x	4.5	-	11	-	-	-	-	-	-	-	-	-	-	8.0	10850	1960	A.I.B.
2282	399	196	1088	34	1448	1942	200	x	4.0	23.3	10.4	0.003	x0.01	0.02	0.01	0.03	1.49	x0.01	10.2	0.21	7240	7.65	5362	1962	A.M.D.L.
2283	358	184	1331	48	1745	1909	222	x	4.35	15	4.7	0.025	x0.01	0.02	0.04	0.06	2.11	x0.01	8.5	0.15	8067	7.65	5794	1962	A.M.D.L.
2287	107	53.6	447	40.0	585	393	319	x	3.95	26.6	6.3	x0.001	x0.01	x0.02	0.01	0.04	1.25	0.01	8.9	0.1	2926	7.95	1806	1962	A.M.D.L.
2288	486	424	2500	68	3860	2848	351	x	3.2	-	6	-	-	-	-	-	-	-	-	-	-	7.5	10546	1961	A.I.B.
2289	207	131	1263	44	1584	1375	280	x	5.0	13.3	0.2	0.001	x0.01	x0.02	0.01	0.08	1.11	x0.01	7.6	0.24	7134	7.8	4815	1962	A.M.D.L.
2412	268	152	800	34	1210	1091	227	x	3.6	-	2.0	-	-	-	-	-	-	-	-	-	-	-	3787	1957	A.I.B.
2498	256	142	680	40	1060	971	309	x	2	10	x2.0	-	-	-	x0.1	x0.2	x0.5	-	3.5	-	4200	7.1	3490	1962	B.M.R.
2499	287.8	172.5	900	47	1407.2	1170.3	309.1	x	3.75	20.0	-	-	-	-	-	-	-	-	-	-	6122	7.2	4242	1962	A.M.D.L.
2500	238	128	652	34.3	944	978	318	x	3.45	22.6	0.3	x0.001	x0.01	x0.03	0.01	0.22	1.1	x0.01	7.5	0.10	4558	7.55	3201	1962	A.M.D.L.
2501	300	165	848	42.3	1287	1218	336	x	3.0	24.5	x0.1	x0.001	x0.01	x0.03	0.02	0.26	1.28	x0.01	7.5	0.10	5731	7.5	4129	1962	A.M.D.L.

APPENDIX C - SHEET 4

Reg. No.	Ca	Mg	Na	K	Cl	SO_4	HCO_3	CO_3	F	SiO_2	NO_3	NO_2	PO_4	Mn	Fe	Al	B	Pb	Sr	Li	S.C.	pH	T.D.S.	YEAR	LABORATORY
2502	330	119	144	15	52	1362	178	x	3.6	-	4	-	-	-	-	-	-	-	-	-	-	7.2	2208	1961	A.I.B.
2503	361.7	107.9	353	22	255.1	1483.5	257	x	5.0	49.8	-	-	-	-	-	-	-	-	-	-	3412	7.4	2803	1962	A.M.D.L.
2504	93	52	345	24	3 10	437	391	x	4.0	-	4	-	-	-	-	-	-	-	-	-	-	7.6	1660	1961	A.I.B.
2505	88	47.5	288	19	260.2	353.1	394.7	x	4.05	19.1	-	-	-	-	-	-	-	-	-	-	2047	7.55	1231	1962	A.M.D.L.
2506	278	174	950	50	1410	1300	298	x	2.0	15	x2.0	-	-	-	x0.1	x0.2	0.5	-	3.0	-	5100	7.0	4190	1962	B.M.R.
2507	66	34.2	224	43	166	279	407	x	3.8	31.4	9.7	0.003	x0.01	x0.05	x0.01	x0.02	0.97	x0.01	3.3	0.06	1660	8.05	1010	1962	A.M.D.L.
2577	54.6	20.0	83.5	20	27.5	37.4	401	x	3.7	51.8	12.8	0.01	0.01	x0.03	0.01	0.04	0.52	x0.01	2.0	x0.05	770	7.55	483	1962	A.M.D.L.
2578	124	55.7	196	31	139	538	313	x	3.95	23.2	3.3	0.003	x0.01	x0.05	x0.01	0.04	0.91	x0.01	9.4	0.11	1857	8.0	1245	1962	A.M.D.L.
2580	31	35	-	-	165	294	316	x	-	-	-	-	-	-	-	-	-	-	-	-	-	8.0	972	1961	A.I.B.
2581	185	121	639	38	1030	679	307	x	2.6	17.7	0.1	x0.001	x0.01	x0.02	x0.01	0.12	0.84	x0.01	2.8	0.1	4502	7.9	2875	1962	A.M.D.L.
2582	212	270	-	-	1685	1751	126	x	-	-	-	-	-	-	-	-	-	-	-	-	-	6.8	5508	1961	A.I.B.
2583	66.3	32.5	188	30	139.4	202.5	385.6	x	2.6	23	-	-	-	-	-	-	-	-	-	-	1417	7.45	829	1962	A.M.D.L.
2585	177	106	723	53	1013	818	340	x	4.2	33.1	7.0	x0.001	x0.01	x0.05	x0.01	x0.02	1.65	x0.01	10.1	0.09	4731	7.9	3099	1962	A.M.D.L.
2586	60.4	30.5	139	39.5	79.4	149	426	x	3.45	27	6.4	0.01	x0.01	x0.03	0.015	0.06	0.7	x0.01	3.6	0.05	1149	7.55	711	1962	A.M.D.L.
2745	48.7	45.5	66	10	80.4	34.6	390	x	0.3	27	0.9	0.025	x0.01	x0.03	0.01	0.08	0.26	x0.01	0.3	x0.05	795	7.7	471	1962	A.M.D.L.
2758	172	80	500	36	570	806	303	x	3	10	4.5	-	-	-	x0.1	x0.2	1	-	8.9	-	2860	7.0	2110	1962	B.M.R.
2901	235.7	116	430	45	690.5	807	269.3	x	3.7	23.3	-	-	-	-	-	-	-	-	-	-	3796	7.15	2522	1962	A.M.D.L.
3100	121.5	62	477	23.5	443.5	602.5	407	x	4.3	19.8	-	-	-	-	-	-	-	-	-	-	3040	7.3	1976	1962	A.M.D.L.
3101	159.4	81.1	416	33	510.2	692.1	281.5	x	3.7	23.3	-	-	-	-	-	-	-	-	-	-	3207	7.3	2097	1962	A.M.D.L.
3102	340	217.6	942	48	1467.2	1491.3	315.2	x	5.73	28.2	-	-	-	-	-	-	-	-	-	-	6665	7.15	4702	1962	A.M.D.L.
3103	287	134	685	28.5	878	1309	283	x	4.3	36.5	1.0	x0.001	0.01	x0.05	x0.01	0.05	1.16	x0.01	17.9	0.22	4896	7.6	3544	1962	A.M.D.L.
3104	143	84.2	474	37	643	579	332	x	3.35	20.1	6.9	0.001	x0.01	x0.02	0.01	0.11	1.13	x0.01	6.6	0.07	3456	7.85	2224	1962	A.M.D.L.
3105	215.5	141.5	937	50	136.5	983.5	297	x	4.75	16.5	-	-	-	-	-	-	-	-	-	-	5916	7.35	3924	1962	A.M.D.L.
3107	95.5	59.5	284	20.5	439.5	296.5	214	x	2.45	20.5	-	-	-	-	-	-	-	-	-	-	2260	7.6	1306	1962	A.M.D.L.
3109	172	97	370	25	460	623	490	x	0.8	15	x2.0	-	-	-	x0.1	x0.2	0.5	-	1	-	2690	7.0	1980	1962	B.M.R.
3110	113	53	456	22	405	602	417	x	4.5	21.3	4.3	0.001	x0.01	x0.05	0.01	0.035	1.15	x0.01	16.3	0.08	2891	7.45	1920	1962	A.M.D.L.
3111	293	168	875	46	1383	1181	312	x	3.8	22.4	x0.1	0.001	x0.01	x0.05	0.01	0.05	1.25	x0.01	6.5	0.1	6099	7.35	4237	1962	A.M.D.L.
3112	384	190	680	25	1119	1456	247	x	2.3	31.8	x0.1	0.002	0.01	x0.05	0.013	0.055	0.62	x0.01	2.3	0.1	5545	7.25	4162	1962	A.M.D.L.
3113	166.7	115.5	690	45.5	1081.6	620.5	373.3	x	5.58	15.8	-	-	-	-	-	-	-	-	-	-	4652	7.45	2935	1962	A.M.D.L.
3114	108.9	54.9	320	47	331.3	444.4	351.9	x	3.5	21.4	-	-	-	-	-	-	-	-	-	-	2409	7.4	1518	1962	A.M.D.L.
3115	77.5	33	94.5	24.2	68.4	81.9	425	x	2.75	34.8	-	-	-	-	-	-	-	-	-	-	1030	7.35	590	1962	A.M.D.L.
3116	101.5	33.5	102.5	17.3	132.9	113.5	334	x	0.65	57.2	-	-	-	-	-	-	-	-	-	-	1220	7.15	760	1962	A.M.D.L.
3118	312.8	177.3	926	66	1389	1232	361.1	x	3.2	23.3	-	-	-	-	-	-	-	-	-	-	6305	7.00	4367	1962	A.M.D.L.

APPENDIX C - SHEET 5

Reg. No.	Ca	Mg	Na	K	Cl	SO_4	HCO_3	CO_3	F	SiO_2	NO_3	NO_2	PO_4	Mn	Fe	Al	B	Pb	Sr	Li	S.C.	pH	T.D.S.	YEAR	LABORATORY
3119	188	155	834	60	1290	765	378	x	3	10	x2.0	-	-	-	x0.1	x0.2	1	-	3.0	-	5100	6.9	3560	1962	B.M.R.
3122	232	176	884	31.5	1520	819	401	x	3.3	14.3	x0.1	x0.001	0.01	x0.03	x0.01	0.45	1.04	x0.01	4.2	0.12	5954	7.6	3970	1962	A.M.D.L.
3147	254	116	329	13.5	572	818	234	x	3.55	17.6	1.6	0.025	0.02	x0.02	x0.01	0.04	0.63	x0.01	7.8	0.2	3285	7.85	2308	1962	A.M.D.L.
3149	161.1	85.5	388	28	523.2	629.2	281.6	x	3.6	16.4	-	-	-	-	-	-	-	-	-	-	3056	7.45	2000	1962	A.M.D.L.
3568	176	126	665	52	1146	587	342	x	2.85	16.3	0.9	0.015	x0.01	x0.02	0.01	0.07	0.99	x0.01	3.4	0.1	4665	7.8	2945	1962	A. M.D.L.
3655	264	202	1240	160	2060	1200	283	x	3	10	x2.0	-	-	-	x0.1	x0.2	2	-	5	-	7140	7.0	5350	1962	B.M.R.
3656	180	151	673	70	1211	558	466	x	3.2	18.4	0.4	0.017	x0.01	x0.05	0.01	0.14	0.95	x0.01	3.7	0.11	4975	7.8	3104	1962	A. M.D.L.
D42 (BRUNETTE DOWNS)	237.5	95.5	557	63.5	161.5	1819	208	x	4.95	23.5	-	-	-	-	-	-	-	-	-	-	3900	7.45	3102	1962	A.M.D.L.
ALROY 1:250,000 SHEET AREA																									
29	108.5	94.5	258	48.5	368.5	199	658	x	2.0	43	-	-	-	-	-	-	-	-	-	-	2393	6.95	1420	1962	A.M.D.L.
41)	59.1	35.4	100	41	33.4	28.0	563.1	x	2.8	50.9	-	-	-	-	-	-	-	-	-	-	1005	7.15	586	1962	A. M.D.L.
41)	60	39	102	40	33	24	610	x	2.9	-	7.0	-	-	-	-	-	-	-	-	-	-	-	918	1960	A.I.B.
124	193	127	463	36.5	787	639	339	x	2.65	31.2	14.3	0.005	x0.01	x0.02	x0.01	x0.02	0.92	x0.01	5.9	0.15	3791	7.7	2488	1962	A.M.D.L.
285	202.7	108.6	293.0	22	579.1	430	422.3	x	1.45	45.1	-	-	-	-	-	-	-	-	-	-	3012	7.00	1899	1962	A.M.D.L.
353	93.4	69.7	116	44	131.6	65.4	627.4	x	1.5	64.5	-	-	-	-	-	-	-	-	-	-	1461	7.00	860	1962	A.M.D.L.
358	51.1	32.1	56	31	28.3	18.5	410	x	1.8	56	-	-	-	-	-	-	-	-	-	-	761	7.35	442	1962	A.M.D.L.
395	484.8	210.3	298	19.8	813.2	1334.5	217.5	x	3.99	34.1	-	-	-	-	-	-	-	-	-	-	4510	7.65	3301	1962	A.M.D.L.
396	136.9	51.9	115	25	112.4	332.5	382.5	x	2.9	35.6	-	-	-	-	-	-	-	-	-	-	1503	7.1	989	1962	A.M.D.L.
403	348	264	998	57.5	2032	1029	345	x	2.55	21.2	15.7	x0.001	x0.001	x0.02	x0.02	x0.02	1.01	x0.01	9.1	0.19	7715	7.6	4886	1962	A.M.D.L.
414	293.1	167.2	540	30	1008.4	897.1	292.2	x	2.3	60.1	-	-	-	-	-	-	-	-	-	-	4694	7.15	3144	1962	A.M.D.L.
500	104	61	140	30	225	115	540	x	0.4	40	22.2	-	-	-	x0.1	x0.2	x0.5	-	1	-	1620	6.9	980	1962	B.M.R.
503	105	54.3	179	18.0	213	279	351	x	1.95	44.0	21.3	0.005	x0.01	x0.02	x0.01	0.02	0.46	x0.01	3.6	0.14	1740	7.7	1071	1962	A.M.D.L.
504	110	69.3	168	20.0	250	174	505	x	1.0	52.4	15.0	0.01	x0.01	x0.02	0.06	0.03	0.42	x0.01	1.6	0.07	1737	7.55	1052	1962	A.M.D.L.
719	150.5	137	507	55.5	838.5	524.5	425	x	2.55	39.6	-	-	-	-	-	-	-	-	-	-	3874	7.25	2526	1962	A.M.D.L.
720	124	97	300	47	533	216	561	x	0.8	-	10	-	-	-	-	-	-	-	-	-	-	-	1888	1957	A.I.B.
722	129.9	81.5	230	34.3	322.8	324.7	501.8	x	1.81	33.3	-	-	-	-	-	-	-	-	-	-	2236	7.2	1415	1962	A.M.D.L.
723	118	113	420	67	600	318	676	x	2.6	-	3	-	-	-	-	-	-	-	-	-	-	-	2317	1957	A.I.B.
724	125	120	490	74	765	334	625	x	2.2	-	3	-	-	-	-	-	-	-	-	-	-	-	2538	1957	A.I.B.
725	100	81	140	44	165	106	732	x	2.0	-	5.0	-	-	-	-	-	-	-	-	-	-	-	1375	1957	A.I.B.
727	116.7	80.4	240	44	396.9	170.4	543.2	x	1.5	45.7	-	-	-	-	-	-	-	-	-	-	2317	7.05	1336	1962	A.M.D.L.
728	170	197	840	105	1310	667	725	x	3.0	-	1.0	-	-	-	-	-	-	-	-	-	-	-	4018	1957	A.I.B.
729	115.5	97	358	59.5	530.5	404	456	x	2.0	34.9	-	-	-	-	-	-	-	-	-	-	2958	7.2	1831	1962	A.M.D.L.

APPENDIX C - SHEET 6

Reg. No.	Ca	Mg	Na	K	Cl	SO_4	HCO_3	CO_3	F	SiO_2	NO_3	NO_2	PO_4	Mn	Fe	Al	B	Pb	Sr	Li	S.C.	pH	T.D.S.	YEAR	LABCRATORY
730	112.7	68.9	218	38	300.7	211.5	538.6	x	1.45	35.6	-	-	-	-	-	-	-	-	-	-	2048	7.1	1274	1962	A.M.D.L.
731	137.1	89.4	267	48	423.2	265.4	526.4	x	1.1	20.4	-	-	-	-	-	-	-	-	-	-	2513	7.1	1472	1962	A.M.D.L.
732	112.3	62.3	151	32	217.7	113.6	569.2	x	1.2	46.4	-	-	-	-	-	-	-	-	-	-	1693	7.1	992	1962	A.M.D.L.
733)	206.2	147.7	563	42	1115.7	495.4	403.9	x	3.45	23.7	-	-	-	-	-	-	-	-	-	-	4546	6.95	2801	1962	A.M.D.L.
733)	198	157	605	41	1120	482	412	x	2.1	-	4.0	-	-	-	-	-	-	-	-	-	-	-	3021	1957	A.I.B.
734	90.8	62.4	148	33	182.2	173.2	514.1	x	1.2	33.1	-	-	-	-	-	-	-	-	-	-	1559	7.2	918	1962	A.M.D.L.
1212	169.3	77.2	196	22	384.7	382.3	319.8	x	2.8	29.8	-	-	-	-	-	-	-	-	-	-	2252	7.25	1417	1962	A.M.D.L.
1236	133	77	217	32	408	193	444	x	1.7	-	x	-	-	-	-	-	-	-	-	-	-	-	1505	1957	A.I.B.
1237	141	92	250	42	458	275	437	x	1.3	-	x	-	-	-	-	-	-	-	-	-	-	-	1698	1957	A.I.B.
1239	63	48	78.5	62.5	75	68.5	511	x	1.6	30.8	-	-	-	-	-	-	-	-	-	-	1146	7.05	659	1962	A.M.D.L.
1240	84	74	160	43	185	95	646	x	1.1	-	17.0	-	-	-	-	-	-	-	-	-	-	-	1305	1958	A.I.B.
1241	99	53	70	20	95	55	527	x	0.2	-	4.0	-	-	-	-	-	-	-	-	-	-	-	923	1957	A.I.B.
1242	92	67.5	146	42.5	168	126	606	x	2.3	30.8	-	-	-	-	-	-	-	-	-	-	1648	7.00	944	1962	A.M.D.L.
2190)	227.2	200.7	1061.3	123	1883.2	817.7	468.2	x	3.72	24	-	-	-	-	-	-	-	-	-	-	7221	7.1	4574	1962	A.M.D.L.
2190)	222	204	1110	124	1968	820	478	x	3.0	-	14	-	-	-	-	-	-	-	-	-	-	-	4943	1957	A.I.B.
2191	482	418	1120	22	1225	3140	370	x	4.0	-	4.0	-	-	-	-	-	-	-	-	-	-	7.2	6785	1961	A.I.B.
2192	107	74	187	322	391	200	769	x	2.6	-	-	-	-	-	-	-	-	-	-	-	-	-	2056	1953	A.I.B.
2193	103	79	230	43	330	139	566	x	2.0	-	4.0	-	-	-	-	-	-	-	-	-	-	-	1496	1957	A.I.B.
2194)	128.1	79.3	284	37.3	469	230.9	477.4	x	2.5	30.7	-	-	-	-	-	-	-	-	-	-	2548	7.1	1458	1962	A.M.D.L.
2194)	124	83	290	39	465	233	493	x	1.8	-	4.0	-	-	-	-	-	-	-	-	-	-	-	1732	1957	A.I.B.
2195)	126.5	118.0	463	64.5	704.5	466.5	496	x	2.6	32.8	-	-	-	-	-	-	-	-	-	-	3576	7.2	2224	1962	A.M.D.L.
2195)	116	118	447	61	670	442	478	x	1.6	-	x	-	-	-	-	-	-	-	-	-	-	-	2333	1957	A.I.B.
2229	634	166.5	154	17.4	273.2	2016	116	x	5.6	15.8	-	-	-	-	-	-	-	-	-	-	3730	7.15	3369	1962	A.M.D.L.
2236	170.2	91.6	333.3	26.3	552.4	477.3	339.5	x	2.69	32.1	-	-	-	-	-	-	-	-	-	-	2880	7.2	1857	1962	A.M.D.L.
2281	507	179	640	23.0	847	2052	160	x	3.65	15.9	5.4	x0.001	x0.01	0.02	x0.01	0.14	1.06	x0.01	9.3	0.31	5576	7.8	4506	1962	A.M.D.L.
2579	163	73.3	164	19.6	320	418	225	x	2.15	36.3	33.1	0.001	x0.01	x0.02	x0.01	0.05	0.4	x0.01	4.7	0.09	2113	7.75	1372	1962	A.M.D.L.
2800	130	65.8	208	29.0	336	242	403	x	2.0	48.2	20.8	0.005	x0.01	x0.02	0.02	0.03	0.44	0.01	5.3	0.09	2067	7.65	1276	1962	A.M.D.L.
2940	49.4	29.2	51.3	32.7	31.1	20.2	354	x	1.2	35.3	46.8	0.015	x0.01	x0.02	x0.01	0.06	0.32	x0.01	1.1	x0.05	751	7.8	437	1962	A.M.D.L.
2942	323	185	-	-	590	1069	196	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2920	1956	A.I.B.
3108	130	108	494	48.0	785	391	495	x	2.8	21.8	13.8	0.005	x0.001	x0.02	0.08	x0.02	0.92	x0.01	2.6	0.09	3686	7.7	2248	1962	A.M.D.L.
3123	246	193	948	78	1644	931	397	x	3.65	15.4	2.6	0.025	x0.01	x0.03	0.015	0.39	1.14	x0.01	4.3	0.14	6462	7.5	4288	1962	A.M.D.L.
3138	139	136	-	-	905	413	577	x	-	-	-	-	-	-	-	-	-	-	-	-	-	7.5	2660	1961	A.I.B.

APPENDIX C - SHEET 7

Reg. No.	Ca	Mg	Na	K	Cl	SO_4	HCO_3	CO_3	F	SiO_2	NO_3	NO_2	PO_4	Mn	Fe	Al	B	Pb	Sr	Li	S.C.	pH	T.D.S.	YEAR	LABORATORY
3139	100	159	630	63	955	658	434	x	2.4	-	2.0	-	-	-	-	-	-	-	-	-	-	6.9	3003	1961	A.I.B.
3140	84	63	145	30	155	125	580	x	0.4	50	4.5	-	-	-	x0.1	x0.2	x0.5	-	x1.0	-	1520	6.9	850	1962	B.M.R.
3141	123.3	83.3	293.3	44.5	512.8	204.9	477.4	x	2.32	31.8	-	-	-	-	-	-	-	-	-	-	2521	7.1	1507	1962	A.M.D.L.
3143	116	78	149	30	260	138	570	x	0.4	50	13.3	-	-	-	x0.1	x0.2	0.5	-	1	-	1650	6.9	1060	1962	B.M.R.
3144	240	221	1220	130	2080	850	650	x	2.0	20	x2.0	-	-	-	x0.1	x0.2	1.5	-	5	-	6490	6.8	5130	1962	B.M.R.
3145	473	411	1080	18	1250	3157	377	x	3.3	-	5.0	-	-	-	-	-	-	-	-	-	-	7.3	6774	1961	A.I.B.
WONARAH)	116.6	75.4	184	30	368.5	125.1	446.8	x	0.7	17.3	-	-	-	-	-	-	-	-	-	-	2016	7.25	1097	1962	A.M.D.L.
WONARAH)	50	-	201	65	378	89	200	x	0.4	-	5.0	-	-	-	-	-	-	-	-	-	-	-	988	1958	A.I.B.
WALLHALLOW 1:250,000 SHEET AREA																									
524	54.1	26.3	86.5	14.5	44.3	65.8	376	x	1.65	43.7	12.8	0.003	0.01	x0.05	x0.01	x0.02	0.47	x0.01	1.1	0.05	833	7.8	471	1962	A.M.D.L.
525	218	109	346	12.5	581.5	705.5	248	x	3.1	25.0	-	-	-	-	-	-	-	-	-	-	3240	7.25	2176	1962	A.M.D.L.
598	414	193	520	17.5	992	1346	216	x	3.35	25.0	1.8	x0.001	x0.01	x0.02	0.01	x0.02	0.55	x0.01	9.7	0.25	4950	7.9	3640	1962	A.M.D.L.
599	328	168	520	21.0	935	1150	205	x	3.25	20.8	2.2	x0.001	x0.01	0.04	0.10	0.03	0.68	x0.01	12.9	0.25	4599	7.9	3296	1962	A.M.D.L.
600	355	199	600	22	1070	1222	232	x	2.7	-	x	-	-	-	-	-	-	-	-	-	-	-	3702	1957	A.I.B.
601	209	101	417	[illegible]	615	772	203	x	3.8	22.3	0.25	x0.001	x0.01	x0.02	0.02	x0.02	0.59	x0.01	16.3	0.3	3361	7.8	2361	1962	A.M.D.L.
605	309	159	385	17.5	842	874	246	x	3.6	19.0	2.7	0.009	x0.01	0.02	0.06	0.02	0.47	x0.01	18.8	0.3	3999	7.9	2702	1962	A.M.D.L.
606	296	176	468	16.0	888	962	311	x	1.2	35.7	2.9	x0.001	x0.01	x0.02	0.01	x0.02	0.8	x0.01	4.6	0.1	4321	7.7	3044	1962	A.M.D.L.
960	110	46.0	24.0	5.1	33.4	50.2	512	x	0.35	28.4	x0.1	x0.001	x0.01	x0.03	0.01	0.08	0.11	x0.01	0.3	x0.05	876	7.35	525	1962	A.M.D.L.
1067	152.5	62	41.5	7.3	65.5	223.5	471	x	0.95	23	-	-	-	-	-	-	-	-	-	-	1250	6.95	827	1962	A.M.D.L.
1070	145	65	90	8.3	132.9	160.5	545	x	0.5	30.6	-	-	-	-	-	-	-	-	-	-	1480	6.85	905	1962	A.M.D.L.
1246	276.5	143	786	37.8	1164	1079	272	x	3.7	21.6	-	-	-	-	-	-	-	-	-	-	5370	7.15	3670	1962	A.M.D.L.
1247	340	190	959	47	1499	1416	296	x	3.6	25.8	0.7	0.004	x0.01	x0.05	x0.01	0.035	1.35	x0.01	7.8	0.1	6702	7.3	4765	1962	A.M.D.L.
1248	578.6	202.9	621	30	1012.4	2011	165.2	x	5.05	45.8	-	-	-	-	-	-	-	-	-	-	5902	7.25	4670	1962	A.M.D.L.
1249	259.6	128.7	680	30	1030.6	992.1	247.9	x	4.45	19.1	-	-	-	-	-	-	-	-	-	-	4853	7.2	3335	1962	A.M.D.L.
1251	135.5	60.6	173	17	235.9	327.6	364.1	x	4.4	47.0	-	-	-	-	-	-	-	-	-	-	1825	7.2	1251	1962	A.M.D.L.
1252	373	218.5	1032	49.0	1514	1592	327	x	3.1	34.6	-	-	-	-	-	-	-	-	-	-	6960	6.95	5042	1962	A.M.D.L.
2158	92.3	53.9	267	13.5	309	336	325	x	1.65	28.5	8.9	x0.001	0.01	0.02	0.01	0.04	0.78	x0.01	1.7	0.06	2010	7.85	1273	1962	A.M.D.L.
2409	56.2	35.8	89.6	8.2	139	79.8	259	x	0.35	17.8	2.9	x0.001	x0.01	x0.03	0.2	0.02	0.45	x0.01	0.4	0.05	955	7.7	545	1962	A.M.D.L.
2410	129	69.2	94.7	9.3	131	119	623	x	0.50	54.4	0.5	x0.005	x0.01	x0.03	0.03	0.06	0.24	x0.01	0.6	0.05	1440	7.2	888	1962	A.M.D.L.
2411	129	62.6	98.2	9.8	145	149	565	x	0.55	42.5	0.2	0.005	x0.01	x0.03	0.01	x0.02	0.23	x0.01	0.9	0.05	1402	7.3	906	1962	A.M.D.L.
2413	283	167.5	880	44.8	1322	1178	294	x	4.0	20.2	-	-	-	-	-	-	-	-	-	-	5980	6.95	4083	1962	A.M.D.L.
2746	36.8	25.8	35.0	6.2	38.7	13.6	268	x	0.1	38.1	x0.1	x0.001	0.02	x0.03	0.01	0.17	0.12	x0.01	x0.2	0.05	524	7.2	304	1962	A.M.D.L.

APPENDIX C - SHEET 8

Reg. No.	Ca	Mg	Na	K	Cl	SO_4	HCO_3	CO_3	F	SiO_2	NO_3	NO_2	PO_4	Mn	Fe	Al	B	Pb	Sr	Li	S.C.	pH	T.D.S.	YEAR	LABORATORY
2751	286	150	760	38	1168	1121	333	x	3.35	19.5	0.1	0.004	x0.01	x0.05	x0.01	0.11	1.05	x0.01	6.3	0.1	6249	7.4	3824	1962	A.M.D.L.
2752	161	82	178	13	270	309	543	x	1.0	28.7	x0.1	0.001	0.018	x0.05	0.02	0.13	0.32	x0.01	1.4	0.05	2033	7.25	1356	1962	A.M.D.L.
RANKEN 1:250,000 SHEET AREA																									
83	80.3	41.3	113	6.4	190	158	222	x	1.25	17.7	1.2	x0.001	x0.01	x0.02	0.02	x0.02	0.26	x0.01	0.9	x0.05	1252	7.9	733	1962	A.M.D.L.
84	69.8	35.6	43.1	6.1	82.2	127	209	x	1.10	19.1	x0.1	x0.001	x0.01	0.02	0.03	x0.02	0.14	x0.01	0.9	x0.05	829	7.9	494	1962	A.M.D.L.
96	93	51.4	62.1	7.2	135.9	188.1	238.5	x	1.24	19.7	-	-	-	-	-	-	-	-	-	-	1090	7.5	598	1962	A.M.D.L.
392	118.9	53.5	124	6.65	220.6	267.5	241.5	x	1.36	18.6	-	-	-	-	-	-	-	-	-	-	1510	7.5	940	1962	A.M.D.L.
495	150	94.5	385	24	580.1	592.1	260.1	x	2.9	22	-	-	-	-	-	-	-	-	-	-	3130	7.75	1988	1962	A.M.D.L.
533	68	32.5	23.6	4.9	29.9	42.4	324.4	x	0.35	20.2	-	-	-	-	-	-	-	-	-	-	641	7.35	374	1962	A.M.D.L.
536	92	47	80	17.1	170	171	221	x	1.19	19.8	-	-	-	-	-	-	-	-	-	-	1200	7.3	682	1962	A.M.D.L.
537	132	74	233	7.7	488	214.5	269	x	1.38	20.6	-	-	-	-	-	-	-	-	-	-	2320	7.25	1289	1962	A.M.D.L.
542	144.5	83	199	5.2	429	217	381	x	0.95	22.6	-	-	-	-	-	-	-	-	-	-	2250	7.15	1259	1962	A.M.D.L.
545	139	74	190	6.6	387	309	235	x	1.13	21.4	-	-	-	-	-	-	-	-	-	-	2100	7.35	1227	1962	A.M.D.L.
735	60	32	30	1	35	66	280	x	1.0	20	x2.0	-	-	-	x0.1	x0.2	x0.5	-	1	-	595	7.3	342	1962	B.M.R.
737	79.5	41.5	94.5	4.9	124.0	133.5	304	x	0.47	20.6	-	-	-	-	-	-	-	-	-	-	1100	7.35	636	1962	A.M.D.L.
738	103.1	44.5	47.1	3.1	102.8	37.4	425.3	x	0.10	19.4	-	-	-	-	-	-	-	-	-	-	1003	6.95	517	1962	A.M.D.L.
744	90	50	245	15	300	340	240	x	2	15	4.5	-	-	-	x0.1	x0.2	x0.5	-	0.5	-	1660	7.3	1160	1962	B.M.R.
747	72	34	32	1	50	45	330	x	0.1	20	11.7	-	-	-	x0.1	x0.2	x0.5	-	x0.5	-	595	7.2	370	1962	B.M.R.
751	53.2	33.7	20.3	3.9	18.8	29.6	319	x	0.45	22.5	0.25	0.014	0.03	x0.02	0.03	x0.02	0.10	x0.01	x0.2	x0.05	523	7.8	294	1962	A.M.D.L.
752	172	69	600	36	820	650	280	x	2.0	20	x2.0	-	-	-	x0.1	x0.2	x0.5	-	0.5	-	3570	7.2	2520	1962	B.M.R.
756	129	71.8	86.2	6.4	217	163	422	x	0.55	21.5	1.9	0.011	x0.01	x0.02	x0.01	x0.02	0.20	x0.01	0.8	x0.05	1388	7.4	875	1962	A.M.D.L.
758	60	35	36	1	40	130	220	x	1.0	20	x2.0	-	-	-	x0.1	x0.2	x0.5	-	1	-	600	7.5	460	1962	B.M.R.
932	152.7	77.7	446	21	585.2	628.8	278.5	x	2.95	17.3	-	-	-	-	-	-	-	-	-	-	3263	7.3	2094	1962	A.M.D.L.
941	79.6	42.5	49.3	5.0	132	94.2	255	x	0.8	19.2	x0.1	0.003	x0.01	x0.02	0.01	0.02	0.19	x0.01	0.7	x0.05	935	7.8	534	1962	A.M.D.L.
944	72.8	40.5	81.5	4.6	160	95.1	234	x	0.9	17.8	x0.1	x0.001	x0.01	x0.02	0.02	x0.02	0.21	x0.01	0.7	x0.05	1024	7.8	548	1962	A.M.D.L.
949	73.1	40.1	61.7	4.8	123	123	228	x	1.0	18.9	x0.1	x0.001	x0.01	x0.02	0.02	0.02	0.18	x0.01	0.8	x0.05	951	7.75	558	1962	A.M.D.L.
951	75	42.1	73.6	6.3	144.8	114.8	232.5	x	1.23	18.3	-	-	-	-	-	-	-	-	-	-	1030	7.5	595	1962	A.M.D.L.
1148	129	80.1	182	22	356.3	202.9	431.5	x	0.75	21.5	-	-	-	-	-	-	-	-	-	-	2084	7.05	1238	1962	A.M.D.L.
1150	70	39	47	2	70	134	250	x	1.0	30	x2.0	-	-	-	x0.1	x0.2	x0.5	-	4	-	1000	7.3	482	1962	B.M.R.
1151	63.6	31.1	28.5	6.2	45.1	68.3	260.1	x	1.35	19.2	-	-	-	-	-	-	-	-	-	-	643	7.3	384	1962	A.M.D.L.
1152	67.8	35.8	29.4	5.6	42.4	86.4	283	x	0.65	20.7	0.1	x0.001	x0.01	x0.02	0.03	0.02	0.18	x0.01	0.4	x0.05	670	7.8	427	1962	A.M.D.L.
1153	85.1	52.7	44.0	4.8	85.9	76.5	379.5	x	1.01	20.4	-	-	-	-	-	-	-	-	-	-	960	7.2	520	1962	A.M.D.L.
1154	64.7	36.6	31.7	3.6	46.3	44.0	321.3	x	1.25	18	-	-	-	-	-	-	-	-	-	-	706	7.25	364	1962	A.M.D.L.

Reg. No.	Ca	Mg	Na	K	Cl	SO_4	HCO_3	CO_3	F	SiO_2	NO_3	NO_2	PO_4	Mn	Fe	Al	B	Pb	Sr	Li	S.C.	pH	T.D.S.	YEAR	LABORATORY
1155	82.5	58.6	60.0	4.1	149.5	51.8	370	x	0.41	20.3	-	-	-	-	-	-	-	-	-	-	1090	7.25	570	1962	A.M.D.L.
1156	71.7	40.4	23.2	5.8	25.7	40.3	391	x	0.75	21.1	x0.1	x0.001	x0.01	x0.02	0.02	x0.02	0.14	x0.01	0.7	x0.05	614	7.7	401	1962	A.M.D.L.
2769	180	119	375	15	800	410	250	x	0.7	20	x2.0	-	-	-	x0.1	x0.2	x0.5	-	1	-	2860	7.2	2090	1962	B.M.R.
3125	72	62	64	1	95	140	360	x	0.5	20	x2.0	-	-	-	x0.1	x0.2	x0.5	-	x0.5	-	970	7.3	620	1962	B.M.R.
3126	72	44	25	2	60	140	230	x	0.7	20	x2.0	-	-	-	x0.1	x0.2	x0.5	-	0.5	-	600	7.4	455	1962	B.M.R.
3133	79.8	37.0	28.3	5	48.1	85.2	302.9	x	0.3	18.2	-	-	-	-	-	-	-	-	-	-	777	7.25	409	1962	A.M.D.L.
3135	70	36	40	2	70	130	220	x	0.7	20	x2.0	-	-	-	x0.1	x0.1	x0.5	-	0.5	-	710	7.2	472	1962	B.M.R.
3136	2.9	2.3	6.1	1.7	7.1	1.6	21.4	x	0.05	14.7	-	-	-	-	-	-	-	-	-	-	74.4	5.6	31	1962	A.M.D.L.
3137	65.1	33.1	22.9	4.7	24	38.3	330.5	x	0.3	21.3	-	-	-	-	-	-	-	-	-	-	629	7.3	333	1962	A.M.D.L.
3156	76.8	40.6	67.5	5.5	162	95.9	225	x	0.7	18.6	x0.1	x0.001	x0.01	0.02	0.07	0.03	0.15	x0.01	0.5	x0.05	1029	7.9	568	1962	A.M.D.L.
3157	61.9	37.1	38.0	4.6	98.5	79.8	206	x	0.85	17.3	x0.1	x0.001	x0.01	x0.02	0.04	0.02	0.18	x0.01	0.5	x0.05	774	7.85	406	1962	A.M.D.L.
3159	76.3	38.6	54.8	6.25	105.9	123	235.5	x	1.36	17.9	-	-	-	-	-	-	-	-	-	-	900	7.45	528	1962	A.M.D.L.
3162	125.5	71.1	170.5	15	324.4	215.2	385.5	x	1.26	22	-	-	-	-	-	-	-	-	-	-	1890	7.1	1132	1962	A.M.D.L.
3163	92	55.5	318	18.4	428	348	223	x	3.08	22.2	-	-	-	-	-	-	-	-	-	-	2340	7.45	1408	1962	A.M.D.L.
MT. DRUMMOND 1:250,000 SHEET AREA																									
531	68.9	34.6	15.8	3.5	19.2	33.3	342.7	x	0.25	22.9	-	-	-	-	-	-	-	-	-	-	623	7.3	343	1962	A.M.D.L.
748	86	41	34.3	6.2	36.5	36.5	439	x	0.41	20.4	-	-	-	-	-	-	-	-	-	-	823	7.15	452	1962	A.M.D.L.
749	82.5	44.5	19.5	6.5	19.3	20.5	464	x	0.38	26.2	-	-	-	-	-	-	-	-	-	-	729	7.15	415	1962	A.M.D.L.
3128	95.6	55.1	16.2	3.3	19.2	20.6	541.6	x	0.35	20.8	-	-	-	-	-	-	-	-	-	-	866	7.00	441	1962	A.M.D.L.
3129	79.8	40.4	11.9	5.5	13.4	26.3	422	x	0.6	19.2	x0.1	x0.001	x0.01	x0.02	0.04	0.04	0.11	x0.01	0.4	x0.05	567	7.75	373	1962	A.M.D.L.
AVON DOWNS 1:250,000 SHEET AREA																									
92	85	-	348	-	497	166	116	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1218	1952	A.I.B.
98	65	-	239	1	319	142	-	104	-	-	-	-	-	-	-	-	-	-	-	-	-	-	878	1952	A.I.B.
331	110	-	430	278*	958	129	98	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1490	1952	A.I.B.
340	161	-	369	-	674	128	146	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1490	1952	A.I.B.
366	85.1	47.1	101.3	8.2	202.3	138.7	229.5	x	1.47	19.6	-	-	-	-	-	-	-	-	-	-	1240	7.7	712	1962	A.M.D.L.
384	81.2	44.2	72.0	7.6	55.7	50.6	492.5	x	1.46	59.3	-	-	-	-	-	-	-	-	-	-	960	7.05	587	1962	A.M.D.L.
994	103	-	286	-	550	203	213	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1604	1952	A.I.B.
1906	108	84	137	13	235	196	453	x	1.2	-	3.0	-	-	-	-	-	-	-	-	-	-	7.4	1230	1960	A.I.B.
1871	114	67	138	17	280	129	400	x	0.6	-	4.0	-	-	-	-	-	-	-	-	-	-	7.6	1150	1959	A.I.B.

* Doubtful value: May be typographical error on original.

APPENDIX D.

BORE WATER ANALYSES - BARKLY TABLELAND

(Giving major ions as equivalents per million and percentages, major ionic ratios, and types of water.

BRUNETTE DOWNS 1:250,000 SHEET AREA

Reg. No.	Na.	K	Na+ K		Ca		Mg		Sc	Cl		SO_4		HCO_3		Sa	Cl	Mg	SO_4	HCO_3	T.D.S.	Ca+Mg	Ca+Mg	TYPE
	epm	epm.	epm	%	epm.	%	epm.	%	epm.	epm	%	epm.	%	epm.	%	epm.	Na+K	Ca	Cl	Cl	S.C.	epm.	Na+K	
112	44.78	1.28	46.06	60	14.6	19	16.2	21	76.86	42.54	56	27.71	36	6.07	8	76.32	0.92	1.11	0.65	0.14	0.71	30.8	0.669 86	Anm
115	2.46	0.56	3.02	34	3.87	43	2.10	23	8.99	1.96	22	1.09	12	5.92	66	8.97	0.65	0.54	0.56	3.02	0.661	5.97	1.977	Cc
116	23.17	2.27	25.44	51	12.20	25	11.68	24	49.32	28.92	61	14.6	30	4.34	9	47.86	1.14	0.96	0.50	0.15	0.648	23.88	0.939	Anc
117	24.39	0.62	25.01	53	11.5	25	10.53	22	47.04	19.44	41	24.17	51	3.64	8	47.25	0.78	0.92	1.24	0.19	0.708	22.03	0.881	BAnc
118	21.74	1.46	23.2	58	8.20	20	8.96	22	40.36	23.94	60	8.06	20	7.77	20	39.77	1.03	1.09	0.34	0.32	0.688	17.16	0.740	Anm
119	25.04	0.81	25.85	57	8.65	19	10.86	24	45.36	28.11	61	9.60	21	8.26	18	45.97	1.09	1.26	0.34	0.29	0.629	19.51	0.755	Anm
123	10.91	0.92	11.83	70	2.97	17	2.14	13	16.94	4.51	27	4.15	25	8.15	48	16.81	0.38	0.72	0.92	1.81	0.635	5.11	0.432	Cnc
317	24.13	1.04	25.17	84	2.62	9	2.1	7	29.89	12.04	41	10.28	35	7.07	24	29.39	0.48	0.80	0.85	0.59	0.627	4.72	0.188	ABnc
360	38.48	1.18	39.96	75	7.00	13	6.58	12	53.24	24.51	46	24.17	46	5.15	9	53.83	0.61	0.94	0.99	0.21	0.720	13.58	0.340	ABnc
394	17.91	0.97	18.88	73	2.15	8	5.02	19	26.05	14.36	49	10.29	35	4.6*	16	29.25	0.76	2.33	0.72	0.32	-	7.17	0.380	ABnm
398	27.39	0.76	28.15	70	6.97	17	5.26	13	40.38	19.34	48	16.48	40	4.72	12	40.54	0.69	0.75	0.85	0.24	0.659	12.23	0.434	ABnc
405	9.57	0.54	10.11	21	26.4	56	10.87	23	47.38	8.16	17	36.61	77	2.61	6	47.38	0.81	0.41	4.49	0.32	0.865	37.27	3.686	Bc
413	12.96	0.59	13.55	48	8.32	29	6.62	23	28.49	12.92	48	8.28	31	5.62	21	26.82	0.95	0.8	0.64	0.43	0.638	14.94	1.102	ABnc
415	11.61	0.54	12.15	29	21.99	51	8.49	20	42.63	10.27	24	29.89	70	2.51	6	42.67	0.85	0.39	2.91	0.24	0.798	30.48	2.509	Bcn
527	29.39	2.0	31.39	65	8.78	18	8.34	17	48.51	24.92	53	16.67	36	5.02	11	46.61	0.79	0.95	0.67	0.20	0.649	17.12	0.545	ABnc
528	6.83	0.35	7.18	49	3.73	26	3.71	25	14.62	7.49	51	3.63	25	3.49	24	14.61	1.04	0.88	0.48	0.47	0.575	7.44	1.036	Anc
530	38.04	1.13	34.17	60	10.8	19	12.01	21	56.98	35.1	61	17.38	30	5.11	9	57.59	1.03	1.11	0.50	0.15	0.659	22.81	0.667	Anm
546	11.3	0.37	11.67	41	9.7	34	7.09	25	28.46	12.62	44	11.23	39	5.03	17	28.88	1.08	0.73	0.89	0.40	0.658	16.79	1.439	ABnc
602	10.26	0.38	10.64	27	18.75	47	10.44	26	39.83	17.49	44	19.04	48	3.23	8	39.76	1.64	0.56	1.09	0.18	0.707	29.19	2.743	BAc
603	8.00	0.82	8.82	62	2.8	19	2.8	19	14.42	2.25	16	4.9	34	7.33	50	14.48	0.26	1.0	2.18	3.26	0.726	5.6	0.635	CBnc
604	1.2	0.29	1.49	16	3.83	40	4.24	44	9.56	0.52	5	0.34	4	8.84	91	9.70	0.35	1.11	0.65	17.0	0.621	8.07	5.416	Cm
761	13.52	0.6	14.12	56	5.32	21	5.63	23	25.07	13.92	56	6.94	28	4.16	16	25.02	0.99	1.06	0.50	0.30	0.594	10.95	0.775	Anm
762	33.43	1.77	35.2	57	13.71	22	12.53	21	61.44	35.02	57	21.79	36	4.36	7	61.17	0.99	0.91	0.62	0.12	0.675	26.24	0.745	Anc
795	36.09	1.33	37.42	71	7.8	15	7.4	14	52.62	22.54	43	23.33	44	6.9	13	52.77	0.60	0.95	1.04	0.31	0.767	15.2	0.406	BAnc
934	16.09	0.9	16.99	59	6.3	22	5.52	19	28.81	13.54	47	8.7	31	6.37	22	28.61	0.80	0.88	0.64	0.47	0.616	11.82	0.696	ABnc
935	38.43	2.07	40.5	55	15.86	21	18.22	24	74.58	43.52	59	26.57	36	3.91	5	74.00	1.07	1.15	0.61	0.09	0.674	34.08	0.841	Anm
1180	13.39	0.26	13.65	43	9.60	30	8.56	27	31.81	16.34	51	11.4	36	4.26	13	32.0	1.20	0.89	0.70	0.26	0.690	18.16	1.330	A Bnc
1181	22.39	0.51	22.9	39	23.4	40	12.17	21	58.47	21.41	36	34.58	59	2.62	5	58.61	0.93	0.52	1.62	0.12	0.924	35.57	1.553	Bcn
1182	4.11	0.81	4.92	44	3.57	32	2.76	24	11.25	2.02	18	2.50	22	6.90	60	11.42	0.41	0.77	1.24	3.42	0.697	6.33	1.286	Cnc
1183	33.91	0.59	34.50	60	12.6	22	10.36	18	57.46	31.55	57	21.04	36	3.93	7	56.52	0.91	0.82	0.67	0.12	0.747	22.96	0.665	Anc

* includes 0.8 e.p.m. $CO_3^{=}$

Water Analyses - Page 2. (Brunette Downs.)

Reg.	Na	K	Na+ K		Ca		Mg		Sc	Cl		SO_4		HCO_3		Sa	Cl	Mg	SO_4	HCO_3	T.D.S.	Ca+Mg	Ca+Mg	TYPE
No.	epm	epm	epm.	%	epm	%	epm.	%	epm	epm.	%	epm.	%	epm	%	epm.	Na+K	Ca	Cl	Cl	S.C.	epm.	Na+K	
1183	17.3	0.67	17.96	55	7.8	24	6.74	21	32.51	15.58	50	9.19	29	6.44	21	31.21	0.87	0.86	0.59	0.41	--	14.54	0.809	Anc
1211	28.09	1.15	29.24	58	9.94	20	10.81	22	49.99	30.8	62	13.29	27	5.62	11	49.71	1.05	1.09	0.43	0.18	0.633	20.75	0.710	Anm
1213	34.17	1.06	35.23	60	11.8	20	11.43	20	58.46	33.8	57	20.36	35	4.66	8	58.82	0.96	0.97	0.60	0.14	0.659	23.23	0.659	Anc
1214	21.13	0.78	21.91	45	13.3	27	13.73	28	48.94	26.31	54	15.21	31	7.26	15	48.78	1.20	1.03	0.58	0.28	0.674	27.03	1.234	Anm
1215	40.26	1.51	41.77	61	12.63	18	14.71	21	69.11	44.37	64	19.55	28	5.72	8	69.64	1.06	1.16	0.44	0.13	0.656	27.34	0.654	Anm
1216	29.39	1.6	30.99	60	8.51	17	11.87	23	51.37	33.17	64	11.38	22	6.97	14	51.52	1.07	1.39	0.34	0.21	0.618	20.38	0.658	Anm
1217	35.3	1.73	37.03	60	11.3	18	13.65	22	61.98	39.07	63	16.1	26	6.72	11	61.89	1.06	1.21	0.41	0.17	0.653	24.95	0.674	Anm
1218	20.48	1.26	21.74	58	6.78	18	9.05	24	37.57	21.39	58	8.16	22	7.52	20	37.07	0.98	1.33	0.38	0.35	0.604	15.83	0.728	Anm
1219	53.48	1.54	55.02	70	11.2	14	12.83	16	79.05	48.45	62	24.17	31	5.33	7	77.95	0.88	1.15	0.5	0.11	1.042	24.03	0.437	Anm
1220	54.78	1.62	56.4	66	12.75	15	16.2	19	85.35	57.18	68	22.81	27	4.36	5	84.35	1.01	1.27	0.40	0.08	0.756	28.95	0.513	Anm
1221	5.57	0.28	5.85	38	4.82	32	4.57	30	15.24	6.5	44	3.02	20	5.32	36	14.84	1.11	0.95	0.46	0.82	0.569	9.39	1.605	ACnc
1222	36.78	1.22	38.00	59	12.72	20	13.31	21	64.03	38.11	59	21.24	33	5.17	8	64.52	1.0	1.05	0.56	0.14	0.660	26.03	0.685	Anm
1223	51.87	1.82	53.69	64	13.37	16	16.51	20	83.57	54.70	66	22.3	27	6.17	7	83.17	1.02	1.23	0.41	0.11	0.651	29.88	0.556	Anm
1225	37.61	1.2	38.81	59	13.83	21	13.32	20	65.96	38.01	57	23.8	36	4.62	7	66.43	0.98	0.96	0.63	0.12	0.682	27.15	0.699	Anc
1227	41.35	1.49	42.84	50	22.92	27	19.89	23	85.65	44.61	52	36.51	43	4.46	5	85.58	1.04	0.87	0.82	0.10	0.732	42.81	0.999	ABnc
1228	24.43	1.41	25.84	58	8.67	19	10.23	23	44.74	27.26	61	9.75	22	7.72	17	44.73	1.05	1.18	0.36	0.28	0.608	18.9	0.731	Anm
1229	61.3	1.42	62.72	53	26.43	22	29.33	25	118.43	64.79	54	50.59	42	4.26	4	119.64	1.03	1.11	0.781	0.07	0.728	55.76	0.889	ABnm
1230	58.78	1.71	60.49	55	22.76	21	25.95	24	109.20	59.66	54	42.26	39	7.93	7	109.85	0.99	1.14	0.71	0.13	0.732	48.71	0.805	ABnm
1250	37.22	1.18	38.4	58	14.75	22	13.45	20	66.69	37.16	56	24.84	37	4.51	7	66.51	0.97	0.91	0.67	0.12	0.680	28.2	0.734	ABnc
1757	36.52	0.95	37.47	51	18.6	25	17.11	24	73.18	37.89	56	27.19	40	2.92	4	68.00x	1.01	0.92	0.72	0.08	-	35.71	0.953	~~Anm~~ AB
1990	33.26	0.92	34.18	52	16.72	26	14.23	22	65.13	33.08	51	27.33	42	4.51	7	64.92	0.97	0.85	0.83	0.14	0.716	30.95	0.905	ABnc
1993	6.74	0.26	7.0	33	7.8	37	6.41	30	21.21	7.46	35	7.35	34	6.64	31	21.45	1.07	0.82	0.99	0.89	0.647	14.21	2.030	ABcn
1995	25.22	0.51	25.73	44	18.05	31	14.39	25	58.19	28.73	49	26.46	45	3.44	6	58.63	1.12	0.80	0.92	0.12	0.779	32.44	1.261	ABnc
1996	27.83	0.51	28.34	50	15.4	27	13.16	23	56.9	28.45	50	25.52	44	3.49	6	58.63	1.00	0.85	0.90	0.12	0.791	28.56	1.008	ABnc
1998	67.39	1.6	68.99	66	19.1	18	17.19	16	105.28	57.97	54	44.56	42	3.98	4	106.51	0.84	0.90	0.77	0.07	0.728	36.29	0.526	ABnc
2157	28.0	0.26	28.26	46	21.85	36	10.86	18	60.97	23.38	38	34.79	57	3.11	5	61.28	0.83	0.50	1.49	0.13	0.838	32.71	1.157	BAnc
2159	12.78	0.51	13.29	73	2.6	14	2.38	13	18.27	7.04	39	4.58	26	6.38	35	18.0	0.53	0.92	0.65	0.91	0.657	4.98	0.375	ACnc
2160	5.78	0.38	6.16	54	3.40	30	1.81	16	11.37	2.11	18	3.17	28	6.11	54	11.39	0.34	0.53	1.50	2.90	0.741	5.21	0.846	Cnc
2161	6.35	0.37	6.72	66	1.73	17	1.78	17	10.23	2.02	20	2.46	24	5.62	56	10.10	0.3	1.03	1.22	2.78	0.613	3.51	0.522	Cnm
2162	17.3	0.51	17.81	48	10.2	28	8.72	24	36.73	17.46	48	15.0	41	3.93	11	36.39	0.98	0.85	0.86	0.23	0.688	18.92	1.062	ABnc
2163	9.74	0.77	10.51	65	2.7	16	3.04	19	16.25	4.51	27	3.44	21	8.64	52	16.59	0.43	1.13	0.76	1.92	0.711	5.74	0.546	Cnm
2222	9.85	0.57	10.42	44	6.89	29	6.24	27	23.55	9.38	41	5.91	26	7.67	33	22.96	0.90	0.91	0.63	0.82	0.631	13.13	1.260	ACnc
2223	11.3	0.62	11.92	48	7.59	31	5.24	21	24.75	9.5	40	8.72	36	5.67	24	23.89	0.80	0.69	0.92	0.60	0.648	12.83	1.076	ABnc

x poor balance.

Water Analyses -,Page 3. (Brunette Downs)

Reg. No.	Na epm.	K. epm.	Na+ K epm.	%	Ca epm.	%	Mg epm.	%	Sc epm.	Cl epm.	%	SO_4 epm.	%	HCO_3 epm.		Sa epm.	Cl / Na+K	Mg / Ca	SO_4 / Cl	HCO_3 / Cl	T.D.S. / S.C.	Ca+Mg epm.	Ca+Mg / Na+K	TYPE
2224	14.22	0.59	14.81	72	3.20	16	2.47	12	20.48	6.20	30	7.63	38	6.43	32	20.26	0.42	0.77	1.23	1.04	0.628	5.67	0.383	BCnc
2225	42.57	1.79	44.36	65	14.71	21	9.77	14	68.84	27.99	42	32.78	49	5.77	9	66.54	0.63	0.66	1.17	0.21	0.725	24.48	0.552	BAnc
2226	40.74	1.33	42.07	70	11.04	18	7.47	12	60.58	22.08	37	31.81	54	5.42	9	59.31	0.52	0.68	1.44	0.25	0.729	18.51	0.440	BAnc
2227	14.26	1.32	15.58	74	3.07	15	2.3	11	20.95	5.01	24	9.56	45	6.52	31	21.09	0.32	0.75	1.91	1.30	0.644	5.37	0.345	BCnc
2228	50.43	0.92	51.35	65	14.12	18	13.12	17	78.59	32.56	41	42.87	54	3.56	5	78.99	0.63	0.93	1.32	0.11	0.743	27.24	0.530	BAnc
2232	24.74	1.65	26.39	63	9.07	22	6.33	15	41.79	9.56	23	27.58	66	4.82	11	41.96	0.36	0.70	2.88	0.50	0.746	15.40	0.583	Bnc
2233	38.48	1.42	39.9	62	14.85	23	10.03	15	64.78	21.99	33	40.5	62	3.11	5	65.60	0.55	0.68	1.84	0.14	0.770	24.88	0.623	Bnc
2234	3.89	0.38	4.27	9	28.15	61	13.61	30	46.03	4.62	10	38.67	86	1.95	4	45.24	1.08	0.48	8.37	0.42	0.946	41.76	9.780	Bc
2235	9.43	0.47	9.9	18	31.15	57	13.36	25	54.31	9.52	18	42.23	78	2.11	4	53.86	0.96	0.43	4.44	0.22	0.892	44.51	4.500	Bc
2280	121.3	1.79	123.09	70	26.75	15	26.73	15	176.57	94.37	55	72.6	42	4.67	3	171.64	0.77	1.0	0.77	0.05	-	53.48	0.434	ABnm
2282	47.3	0.87	48.17	57	19.95	24	16.12	19	84.24	40.79	48	40.46	48	3.28	4	84.53	0.85	0.81	0.99	0.08	0.741	36.07	0.749	ABnc
2283	57.87	1.23	59.10	64	17.9	19	15.13	17	92.13	49.15	53	39.77	43	3.64	4	92.56	0.83	0.85	0.81	0.07	0.718	33.03	0.559	ABnc
2287	19.43	1.03	20.46	68	5.35	18	4.41	14	30.22	16.48	53	8.19	27	5.23	18	29.90	0.81	0.82	0.50	0.32	0.617	9.76	0.4770	Anc
2288	108.7	1.74	110.44	65	24.3	14	34.87	21	169.61	108.87	63	59.33	34	5.75	3	173.94	0.99	1.43	0.54	0.05	-	59.17	0.536	Anm
2289	54.91	1.13	56.04	73	10.35	13	10.77	14	77.16	44.62	57	28.65	37	4.59	6	77.86	0.80	1.04	0.64	0.10	0.675	21.12	0.377	Anm
2412	34.78	0.87	35.65	58	13.4	22	12.5	20	61.55	34.08	56	22.73	37	3.72	7	60.53	0.96	0.93	0.67	0.11	-	25.9	0.726	ABnc
2498	29.57	1.03	30.60	56	12.8	23	11.68	21	55.08	29.86	54	20.23	37	5.07	9	55.16	0.98	0.91	0.68	0.17	0.831	24.48	0.800	ABnc
2499	39.13	1.21	40.34	58	14.39	21	14.19	21	68.92	39.64	58	24.38	35	5.07	7	69.09	0.98	0.99	0.62	0.13	0.693	28.58	0.708	Anm
2500	28.35	0.88	29.23	57	11.9	23	10.53	20	51.66	26.59	51	20.38	39	5.21	10	52.18	0.91	0.88	0.77	0.20	0.702	22.43	0.767	ABnc
2501	36.87	1.08	38.95	57	15	23	13.57	20	66.52	36.25	54	25.38	38	5.51	8	67.14	0.93	0.90	0.70	0.15	0.720	28.57	0.733	ABnc
2502	6.26	0.38	6.64	20	16.5	50	9.79	30	32.93	1.46	4	28.38	87	2.92	9	32.76	0.22	0.59	20.18	2.00	-	26.29	3.959	Bc
2503	15.35	0.56	15.91	37	18.08	42	8.87	21	42.86	7.19	17	30.91	73	4.21	10	42.31	0.45	0.49	4.30	0.59	0.821	26.95	1.694	Bcn
2504	15.0	0.62	15.62	64	4.65	19	4.28	17	24.55	8.73	36	9.10	38	6.41	26	24.24	0.56	0.92	1.04	0.73	-	8.93	0.572	BAnc
2505	12.52	0.49	13.01	61	4.40	21	3.91	18	21.32	7.33	35	7.36	35	6.47	30	21.16	0.56	0.89	1.00	0.88	0.601	8.31	0.639	ABnc
2506	41.3	1.3	42.6	60	13.9	20	14.3	20	70.8	39.72	55	27.1	38	4.89	7	71.71	0.93	1.03	0.68	0.12	0.821	28.2	0.662	ABnm
2507	9.74	1.1	10.84	63	3.3	20	2.81	17	16.95	4.68	27	5.81	34	6.67	39	17.16	0.43	0.85	1.24	1.43	0.608	6.11	0.564	CBnc
2577	3.63	0.51	4.14	49	2.73	32	1.64	19	8.51	0.77	9	0.78	10	6.57	81	8.12	0.19	0.6	1.01	8.53	0.627	4.37	1.055	Cnc
2578	8.52	0.79	9.31	46	6.2	31	4.58	23	20.09	3.92	20	11.21	55	5.13	25	20.26	0.42	0.74	2.86	1.31	0.670	10.78	1.158	~~B~~CncB
2580	N.det.	N.det.	11.52 ẋ	72	1.55	10	2.88	18	15.95	4.64	29	6.13	38	5.18	33	15.95	0.40	1.86	1.32	1.12	-	4.43	0.384	BCnm
2581	27.78	0.97	28.75	60	9.25	19	9.95	21	47.95	29.01	60	14.15	29	5.03	11	48.19	1.00	1.08	0.49	0.17	0.639	19.20	0.668	Anm
2582	N.det	N.det.	53.21 ẋ	62	10.60	12	22.20	26	86.01	47.46	55	36.48	42	2.07	3	86.01	0.89	2.09	0.77	0.04	-	32.8	0.616	ABnm
2583	8.17	0.77	8.94	60	3.31	22	2.67	18	14.92	3.93	27	4.22	29	6.32	44	14.47	0.44	0.81	1.07	1.61	0.585	5.98	0.669	CBnc
2585	31.43	1.36	32.79	65	8.85	18	8.72	17	50.36	28.54	56	17.04	33	5.57	11	51.15	0.87	0.99	0.60	0.20	0.655	17.57	0.536	Anc

ẋ- obtained by balancing.

Water Analyses. Page 4. Brunette Downs.

Reg. No.	Na epm.	K epm.	Na+K epm.	Na+K %	Ca epm.	Ca %	Mg epm.	Mg %	Sc epm	Cl epm.	Cl %	SO_4 epm.	SO_4 %	HCO_3 epm	HCO_3 %	Sa epm.	Cl / Na+K	Mg / Ca	SO_4 / Cl	HCO_3 / Cl	T.D.S. / S.C.	Ca+Mg epm.	Ca+Mg / Na+K	TYPE
2586	6.04	1.01	7.05	55	3.02	25	2.51	20	12.58	2.24	18	3.1	25	6.98	57	12.32	0.32	0.83	1.38	3.12	0.619	5.53	0.784	Cnc
2745	2.87	0.26	3.13	34	2.44	26	3.74	40	9.31	2.26	24	0.72	8	6.39	68	9.37	0.72	1.53	0.31	2.83	0.592	6.18	1.974	Cmn
2758	21.74	0.92	22.66	60	8.6	23	6.58	17	37.84	16.06	43	16.79	44	4.97	13	37.82	0.71	0.76	1.05	0.31	0.738	15.18	0.670	BAnc
2901	18.7	1.15	19.85	48	11.78	29	9.54	23	41.17	19.45	48	16.81	41	4.41	11	40.67	0.98	0.81	1.16	0.23	0.664	21.32	1.074	ABnc
3100	20.74	0.6	21.34	66	6.07	18	5.10	16	32.51	12.49	39	12.55	40	6.67	21	31.7	0.58	0.84	1.00	0.53	0.650	11.17	0.523	~~ABnc~~ BA
3101	18.09	0.85	18.94	56	7.97	24	6.67	20	33.58	14.37	43	14.42	43	4.61	14	33.40	0.76	0.84	1.00	0.32	0.654	14.64	0.7730	~~ABnc~~ BA
3102	40.96	1.23	42.19	55	17.00	22	17.89	23	42.18	41.33	53	31.07	40	5.17	7	77.57	0.98	1.05	0.75	0.13	0.705	38.89	0.922	ABnm
3103	29.78	0.73	30.51	54	14.35	26	11.02	20	55.88	24.73	44	27.27	48	4.64	8	56.64	0.81	0.77	1.10	0.19	0.724	35.39	1.159	BAnc.
3104	20.61	0.95	21.56	61	7.15	20	6.92	19	35.63	18.11	51	12.06	34	5.44	15	35.61	0.84	0.97	0.67	0.30	0.643	14.07	0.652	ABnc
3105	40.74	1.28	42.02	65	10.77	17	11.64	18	64.43	38.45	60	20.49	32	4.87	8	63.81	0.92	1.08	0.53	0.13	0.663	22.41	0.533	Anm
3107	12.35	0.53	12.87	57	4.77	21	4.89	22	22.54	12.38	56	6.18	28	3.51	16	22.07	0.96	1.03	0.50	0.28	0.578	9.66	0.750	Anm
3109	16.09	0.64	16.73	50	8.6	26	7.98	24	33.31	12.96	38	12.98	38	8.03	24	33.97	0.77	0.93	1.00	0.62	0.736	16.58	0.991	~~ABnc~~ BA
3110	19.83	0.56	20.39	67	5.65	19	4.36	14	30.40	11.41	37	15.24	41	6.84	22	30.79	0.56	0.77	1.34	0.60	0.664	10.01	0.491	BAnc
3111	38.04	1.18	39.22	58	14.62	22	13.82	20	67.66	38.96	57	24.6	36	5.11	7	68.69	0.99	0.95	0.63	0.13	0.695	28.44	0.725	Anc
3112	29.57	0.64	30.21	47	19.2	29	15.63	24	65.04	31.52	48	30.33	46	4.05	6	65.9	1.04	0.81	0.96	0.13	0.750	34.83	1.153	ABnc
3113	30.0	1.17	31.17	64	8.33	17	9.5	19	49.00	30.47	62	12.92	26	6.12	12	49.49	0.98	1.14	0.42	0.20	0.631	17.83	0.572	Anm
3114	13.91	1.2	15.11	60	5.44	22	4.51	18	25.06	9.33	38	9.26	38	5.77	24	24.36	0.62	0.83	0.99	0.62	0.630	9.95	0.658	ABnc
3115	4.11	0.62	4.73	42	3.87	34	2.71	24	11.31	1.93	18	1.71	16	6.97	66	10.61	0.41	0.70	0.89	3.61	0.573	6.58	1.391	Cnc
3116	4.46	0.44	4.9	38	5.07	40	2.75	22	12.72	3.74	33	2.36	20	5.48	47	11.58	0.76	0.54	0.63	1.47	0.623	7.82	1.596	CAc
3118	40.26	1.69	41.95	58	15.64	22	14.58	20	72.17	39.13	55	25.67	36	5.92	9	70.72	0.93	0.93	0.66	0.15	0.693	30.22	0.720	ABnc
3119	36.26	1.54	37.8	63	9.4	16	12.75	21	59.95	36.34	62	15.94	27	6.2	11	58.48	0.96	1.36	0.44	0.17	0.698	22.15	0.5860	Anm
3122	38.43	0.81	39.24	60	11.6	18	14.47	22	65.31	42.82	64	17.06	26	6.57	10	66.45	1.09	1.25	0.40	0.15	0.667	26.07	0.664	Anm
3147	14.3	0.35	14.65	40	12.7	34	9.54	26	36.89	16.11	44	17.04	46	3.84	10	36.99	1.10	0.75	1.06	0.24	0.702	22.24	1.518	BAnc
3149	16.87	0.72	17.59	54	8.05	25	7.03	21	32.67	14.74	46	13.11	40	4.62	14	32.47	0.84	0.87	0.89	0.31	0.654	15.08	0.857	ABnc
3568	28.91	1.33	30.24	61	8.8	18	10.36	21	49.4	32.28	64	12.23	25	5.61	11	50.12	1.07	1.18	0.38	0.17	0.631	19.16	0.633	Anm
3655	53.91	4.1	58.01	66	13.2	15	16.61	19	87.82	58.03	66	25.0	29	4.64	5	87.67	1.00	1.26	0.43	0.08	0.749	29.81	0.514	Anm
3656	29.26	1.79	31.05	38	9.0	19	12.42	23	53.47	34.11	64	11.63	22	7.64	14	53.38	1.10	1.38	0.34	0.22	0.624	21.42	0.690	Anm
D42	24.2	1.63	25.83	57	11.88	26	7.85	17	45.56	4.55	10	37.90	83	3.41	7	45.86	0.18	0.66	8.33	0.75	0.795	19.73	0.764	Bnc

Reg. No.	Na epm.	K epm	Na+K epm.	%	Ca epm.	%	Mg epm.	%	Sc epm.	Cl epm.	%	SO_4 epm.	%	HCO_3 epm.	%	Sa epm.	Cl / Na+K	Mg / Ca	SO_4 / Cl	HCO_3 / Cl	T.D.S. / S.C.	Ca+Mg epm.	Ca+Mg / Na+K	TYPE
29	11.22	1.24	12.46	49	5.42	21	7.77	30	25.65	10.38	41	4.15	16	10.79	43	25.32	0.83	1.43	0.40	1.04	0.593	13.19	1.058	CAnm
41	4.35	1.05	5.40	48	2.95	26	2.91	26	11.26	0.94	9	0.58	5	9.23	86	10.75	0.17	0.99	0.62	9.82	0.583	5.86	1.085	Cnc
124	20.13	0.94	21.07	51	9.65	24	10.44	25	41.16	22.17	54	13.31	32	5.56	14	41.04	1.05	1.08	0.60	0.25	0.656	20.09	0.953	Anm
285	12.74	0.56	13.30	41	10.13	31	8.93	28	32.34	16.31	51	8.96	28	6.92	21	32.19	1.23	0.88	0.55	0.42	0.630	19.06	1.433	Anc
353	5.04	1.13	6.17	37	4.67	28	5.73	35	16.57	3.71	24	1.36	9	10.29	67	15.36	0.60	1.23	0.40	2.77	0.589	10.40	1.685	Cnm
358	2.43	0.79	3.22	38	2.55	30	2.64	32	8.41	0.80	10	0.39	5	6.72	85	7.91	0.25	1.04	0.49	8.40	0.581	5.19	1.612	Cnm
395	12.96	0.51	13.47	25	24.24	44	17.29	31	55.00	22.91	42	27.80	51	3.57	7	54.28	1.70	0.71	1.21	0.16	0.732	41.53	3.083	BAc
396	5.00	0.64	5.64	34	6.84	41	4.27	25	16.75	3.17	19	6.93	43	6.27	38	16.37	0.56	0.62	2.19	1.98	0.658	11.11	1.970	BCcn
403	43.39	1.47	44.86	53	17.4	21	21.71	26	83.97	57.24	68	21.44	25	5.66	7	84.34	1.28	1.25	0.37	0.10	0.633	39.11	0.872	Anm
414	23.48	0.77	24.25	46	14.65	28	13.75	26	52.65	28.41	55	18.69	36	4.79	9	51.89	1.17	0.94	0.66	0.17	0.670	28.40	1.171	ABnc
500	6.09	0.77	6.86	41	5.2	30	5.02	29	17.06	6.34	36	2.4	14	8.85	50	17.59	0.92	0.97	0.38	1.40	0.605	10.22	1.490	CAnm
503	7.78	0.46	8.24	46	5.25	29	4.47	25	17.96	6.0	34	5.81	33	5.75	33	17.56	0.73	0.85	0.97	0.96	0.615	9.72	1.180	ABnc
504	7.3	0.51	7.81	41	5.5	29	5.7	30	19.01	7.04	37	3.63	19	8.28	44	18.95	0.90	0.20	0.52	1.18	0.606	11.20	1.434	CAnm
719	22.04	1.42	23.46	55	7.52	18	11.27	27	42.25	23.62	57	10.93	26	6.97	17	41.52	1.01	1.50	0.46	0.30	0.652	18.79	0.801	Anm
720	13.04	1.21	14.25	50	6.20	22	7.98	28	28.43	15.01	52	4.50	16	0.20	32	28.71	1.05	1.29	0.30	0.01	-	14.18	0.995	ACnm
722	10.0	0.88	10.88	45	6.48	27	6.7	28	24.06	9.10	38	6.76	28	8.23	34	24.09	0.84	1.03	0.74	0.90	0.633	13.18	1.211	ACnm
723	18.26	1.72	19.98	57	5.90	17	9.29	26	35.17	16.90	49	6.63	19	11.08	32	34.61	0.85	1.57	0.40	0.66	-	15.19	0.760	ACnm
724	21.30	1.90	23.20	59	6.25	16	9.87	25	39.32	21.55	56	6.96	18	10.25	26	38.76	0.93	1.58	0.32	0.48	-	16.12	0.695	~~AC~~nm A
725	6.09	1.13	7.22	38	5.00	27	6.66	35	18.88	4.65	25	2.21	12	12.00	63	18.86	0.64	1.33	0.48	2.58	-	11.66	1.615	Cnm
727	10.43	1.13	11.56	48	5.83	24	6.61	28	24.00	11.18	47	3.55	15	8.90	38	23.63	0.97	1.13	0.32	0.80	0.577	12.44	1.076	ACnm
728	36.52	2.69	39.21	61	8.50	13	16.20	26	63.91	36.90	59	13.90	22	11.89	19	62.69	0.94	1.91	0.38	0.32	-	24.70	0.630	~~AB~~nm A
729	15.57	1.53	17.1	55	5.77	19	7.98	26	30.85	14.94	49	8.42	27	7.48	24	30.84	0.87	1.38	0.56	0.50	0.619	13.75	0.804	Anm
730	9.48	0.97	10.45	48	5.63	26	5.67	26	21.75	8.47	39	4.41	20	8.83	41	21.71	0.81	1.01	0.52	1.04	0.622	11.30	1.081	CAnm
731	11.61	1.23	12.84	48	6.86	25	7.35	27	27.05	11.92	46	5.53	21	8.63	33	26.08	0.93	1.07	0.46	0.72	0.586	14.21	1.107	ACnm
732	6.57	0.82	7.39	41	5.61	31	5.12	28	18.12	6.13	35	2.37	13	9.33	52	17.83	0.83	0.91	0.39	1.52	0.586	10.73	1.452	CAnc
733	24.48	1.08	25.56	53	10.31	22	12.15	25	48.02	31.43	65	10.32	21	6.62	14	48.37	1.24	1.18	0.33	0.21	0.616	22.46	0.879	Anm
734	6.43	0.85	7.28	43	4.54	27	5.13	30	16.95	5.13	30	3.61	21	8.43	49	17.17	0.70	1.13	0.70	1.64	0.589	9.67	1.328	CAnm
1212	8.52	0.56	9.08	38	8.46	35	6.35	27	23.89	10.84	45	7.96	33	5.24	22	24.04	1.19	0.75	0.73	0.48	0.629	14.81	1.631	ABnc
1236	9.43	0.82	10.25	44	6.65	29	6.33	27	23.23	11.49	50	4.02	18	7.28	32	22.79	1.12	0.95	0.35	0.63	-	12.98	1.266	ACnc
1237	10.87	1.08	11.95	45	7.05	27	7.57	28	26.57	12.90	50	5.73	22	7.16	28	25.79	1.08	1.07	0.44	0.56	-	14.62	1.223	ACnm
1239	3.41	1.6	5.01	41	3.15	26	3.95	33	12.11	2.11	18	1.43	12	8.38	70	11.92	0.42	1.25	0.68	3.97	0.575	7.10	1.417	Cnm
1240	6.96	1.10	8.06	44	4.20	23	6.09	33	18.35	5.21	29	1.98	11	10.59	60	17.78	0.65	1.45	0.38	2.03	-	10.29	1.277	Cnm
1241	3.04	0.51	3.55	28	4.95	38	4.36	34	12.85	2.68	21	1.15	9	8.64	70	12.47	0.75	0.88	0.43	3.22	-	9.31	2.623	Cc

Water Analyses - Page 6. Alroy.

Reg.No.	Na epm.	K epm.	Na+K epm.	%	Ca epm.	%	Mg epm.	%	Sc epm.	Cl epm.	%	SO_4 epm.	%	HCO_3 epm.	%	Sa epm	Cl/Na+K	Mg/Ca	SO_4/Cl	HCO_3/Cl	T.D.S./S.C.	Ca+Mg epm	Ca+Mg/Na+K	TYPE
1242	6.35	1.09	7.44	42	4.6	26	5.55	32	17.59	4.73	27	2.63	15	9.93	58	17.29	0.64	1.21	0.56	2.10	0.573	10.15	1.364	Cnm
2190	46.14	3.15	49.29	64	11.36	15	16.50	21	77.15	53.05	68	17.03	22	7.68	10	77.76	1.08	1.45	0.32	0.14	0.633	27.86	0.565	Anm
2191	48.7	0.56	49.26	46	24.1	22	34.38	32	107.74	34.51	32	65.42	62	6.07	6	106.00	0.70	1.43	1.47	0.18	-	58.48	1.187	Bnm
2192	8.13	8.26	16.39	59	5.35	19	6.09	22	27.83	11.01	40	4.17	15	12.61	45	27.79	0.67	1.14	0.38	1.15	-	11.44	0.6980	CAnm
2193	10.00	1.10	11.10	49	5.15	23	6.50	28	22.75	9.30	43	2.90	14	9.28	43	21.48	0.84	1.26	0.31	1.00	-	11.65	1.050	~~CAnm~~ AC
2194	12.35	0.96	13.31	51	6.4	24	6.52	25	26.23	13.21	51	4.81	19	7.83	30	25.85	0.99	1.02	0.36	0.59	0.572	12.92	0.971	Anm
2195	20.13	1.65	21.78	57	6.32	17	9.7	26	37.80	19.84	53	9.72	26	8.13	21	37.69	0.91	1.53	0.49	0.41	0.622	16.02	0.736	Anm
2229	6.7	0.45	7.15	14	31.7	60	13.09	26	52.54	7.70	15	42.00	81	1.90	4	51.6	1.08	0.43	5.45	0.25	0.903	45.39	6.348	Bc
2236	14.49	0.67	15.16	49	8.51	27	7.53	24	31.2	15.56	50	9.94	32	5.57	18	31.07	1.03	0.88	0.64	0.36	0.645	16.04	1.058	ABnc
2281	27.83	0.59	28.42	42	25.35	37	14.72	21	68.49	23.86	34	42.75	62	2.62	4	69.23	0.84	0.58	1.79	0.11	0.808	40.07	1.410	Bnc
2579	7.13	0.5	7.63	35	8.15	37	6.03	28	21.81	9.01	42	8.71	41	3.69	17	21.41	1.18	0.74	0.97	0.41	0.649	14.48	1.898	ABcn
2800	9.04	0.74	9.78	45	6.5	30	5.41	25	21.69	9.46	45	5.04	24	6.61	31	21.11	0.97	0.83	0.53	0.70	0.617	11.91	1.218	ACnc
2940	2.23	0.84	3.07	39	2.47	31	2.4	30	7.94	0.88	11	0.42	5	5.8	74	7.85[M]	0.29	0.97	0.48	6.59[M]	0.582	4.87	1.586	Cnc
2942	N.det.	N.det.	10.74[a]	26	16.15	38	15.21	36	42.1	16.62	39	22.27	53	3.21	8	42.10	1.55	0.94	1.34	0.19	-	31.36	2.920	BAc
3108	21.48	1.23	22.71	60	6.5	17	8.88	23	38.09	22.11	58	8.15	21	8.11	21	38.37	0.97	1.37	0.37	0.37	0.610	15.38	0.677	Anm
3123	41.22	2.0	43.22	61	12.3	17	15.87	22	71.39	46.31	64	19.4	27	6.51	9	72.22	1.07	1.29	0.42	0.14	0.663	28.17	0.652	Anm
3138	N.det.	N.det.	25.43[a]	58	6.95	16	11.18	26	43.55	25.49	58	8.6	20	9.46	22	43.55	1.00	1.61	0.34	0.37	-	18.13	0.713	~~ACnm~~ A
3139	27.39	1.62	29.01	62	5.00	10	13.08	28	47.09	26.9	56	13.71	29	7.11	15	47.72	0.93	2.62	0.51	0.26	-	18.08	0.623	Anm
3140	6.30	0.77	7.07	43	4.2	25	5.18	32	16.45	4.37	26	2.6	16	9.51	58	16.48	0.62	1.23	0.59	2.18	0.559	9.38	1.327	Cnm
3141	12.75	1.14	13.89	52	6.16	23	6.85	25	26.90	14.45	55	4.27	16	7.83	29	26.55	1.04	1.11	0.30	0.54	0.598	13.01	0.937	~~ACnm~~ A
3143	6.48	0.77	7.25	37	5.8	30	6.41	33	19.46	7.32	37	2.87	15	9.34	48	19.53	1.01	1.11	0.39	1.28	0.642	12.21	1.684	CAnm
3144	53.04	3.33	56.37	65	12.0	14	18.17	21	86.54	58.59	68	17.71	20	10.66	12	86.96	1.04	1.51	0.30	0.18	0.790	30.17	0.535	Anm
3145	46.96	0.46	47.42	45	23.65	23	33.8	32	104.87	35.21	23	65.77	61	6.18	6	107.16	0.74	1.43	1.87	0.18	-	57.45	1.212	Bnm
Wonarah	8.00	0.77	8.77	42	5.83	28	6.2	30	20.80	10.38	51	2.61	13	7.32	36	20.31	1.18	1.06	0.25	0.71	0.544	12.03	1.372	ACnm

WALLHALLOW 1:250,000 SHEET AREA

Reg.No.	Na epm.	K epm.	Na+K epm.	%	Ca epm.	%	Mg epm.	%	Sc epm.	Cl epm.	%	SO_4 epm.	%	HCO_3 epm.	%	Sa epm	Cl/Na+K	Mg/Ca	SO_4/Cl	HCO_3/Cl	T.D.S./S.C.	Ca+Mg epm	Ca+Mg/Na+K	TYPE
524	3.76	0.37	4.13	46	2.71	30	2.16	24	9.00	1.25	14	1.37	16	6.16	70	8.78	0.30	0.80	1.10	4.93	0.565	4.87	1.179	Cnc
525	15.04	0.32	15.36	44	10.9	31	8.96	25	35.22	16.38	47	14.7	42	4.07	11	35.15	1.07	0.82	0.90	0.25	0.672	19.86	1.293	ABnc
598	22.61	0.45	23.06	39	20.7	35	15.87	26	59.63	27.94	47	28.04	47	3.54	6	59.52	1.21	0.77	1.00	0.13	0.735	36.57	1.586	ABnc
599	22.61	0.54	23.15	43	16.4	31	13.82	26	53.37	26.34	49	23.96	45	3.36	6	53.66	1.14	0.84	0.91	0.13	0.717	30.22	1.305	ABnc
600	26.09	0.56	26.65	44	17.75	29	16.37	27	60.77	30.14	51	25.46	43	3.80	6	59.40	1.13	0.92	0.84	0.13	-	34.12	1.280	ABnc
601	18.13	0.63	18.76	50	10.45	28	8.31	22	37.52	17.32	47	16.08	44	3.33	9	36.73	0.92	0.8	0.93	0.19	0.702	18.76	1.000	ABnc
605	16.74	0.45	17.19	38	15.45	34	13.08	28	45.72	23.72	52	18.21	40	4.03	8	45.96	1.38	0.85	0.77	0.17	0.676	28.53	1.660	ABnc
606	20.35	0.41	20.76	41	14.8	30	14.47	29	50.03	25.01	50	20.04	40	5.1	10	50.15	1.20	0.98	0.8	0.20	0.704	29.27	1.410	ABnc

(a) obtained by balancing.

[M] includes 0.75 epm. (10%) NO_3

Water Analyses - Page 7. Wallhallow.

Reg. No.	Na epm.	K epm.	Na+K epm.	%	Ca epm.	%	Mg epm.	%	Sc epm.	Cl epm.	%	SO_4 epm.	%	HCO_3 epm.	%	Sa epm.	Cl / Na+K	Mg / Ca	SO_4 / Cl	HCO_3 / Cl	T.D.S. / S.C.	Ca+Mg epm.	Ca+Mg / Na+K	TYPE
960	1.04	0.13	1.17	11	5.5	53	3.78	36	10.45	0.94	9	1.05	10	8.39	81	10.38	0.80	0.69	1.12	8.93	0.599	9.28	7.931	Cc
1067	1.8	0.19	1.99	13	7.62	52	5.10	35	14.71	1.85	13	4.66	33	7.72	54	14.23	0.93	0.67	2.52	4.17	0.662	12.72	6.392	CBc
1070	3.91	0.21	4.12	25	7.25	43	5.35	32	16.72	3.74	23	3.34	21	8.93	56	16.01	0.91	0.74	0.89	2.39	0.611	12.60	3.058	Cc
1246	34.17	0.97	35.14	58	13.82	23	11.76	19	60.72	32.79	55	22.48	38	4.46	7	59.73	0.93	0.85	0.69	0.14	0.683	25.58	0.728	ABnc
1247	41.7	1.21	42.91	57	17.0	22	15.63	21	75.54	42.23	55	29.5	39	4.85	6	76.58	0.98	0.92	0.70	0.11	0.711	32.63	0.760	ABnc
1248	27.0	0.77	27.77	38	28.93	39	16.69	23	73.39	28.52	39	41.9	57	2.71	4	73.13	1.03	0.56	1.47	0.10	0.791	45.62	1.643	BAc
1249	29.57	0.77	30.34	56	12.98	24	10.58	20	53.87	29.03	54	20.67	38	4.06	8	53.79	0.96	0.82	0.71	0.14	0.687	23.56	0.777	ABnc
1251	7.52	0.44	7.96	41	6.77	34	4.98	25	19.71	6.65	34	6.82	35	5.97	31	19.44	0.84	0.74	1.03	0.90	0.685	11.75	1.476	BAnc
1252	44.91	1.26	46.16	56	18.65	22	17.97	22	82.79	42.65	52	33.17	41	5.36	7	81.18	0.92	0.96	0.78	0.13	0.724	36.62	0.793	ABnc
2158	11.61	0.35	11.96	57	4.62	22	4.43	21	21.01	8.7	41	7.00	33	5.33	26	21.03	0.73	0.96	0.80	0.61	0.633	9.05	0.757	ABnc
2409	3.9	0.21	4.11	42	2.81	28	2.94	30	9.86	3.92	40	1.66	17	4.25	43	9.83	0.95	1.05	0.42	1.08	0.571	5.75	1.399	CAnm
2410	4.12	0.24	4.36	26	6.45	39	5.69	35	16.5	3.69	23	2.48	15	10.21	62	16.38	0.85	0.88	0.65	2.77	0.617	11.14	2.555	Cc
2411	4.27	0.25	4.52	28	6.45	40	5.15	32	16.12	4.08	25	3.1	19	9.26	56	16.44	0.90	0.80	0.80	2.27	0.646	11.60	2.566	Cc
2413	38.26	1.15	39.41	59	14.15	21	13.77	20	67.33	37.24	56	24.54	37	4.82	7	66.6	0.94	0.97	0.66	0.13	0.683	27.92	0.708	ABnc
2746	1.52	0.16	1.68	30	1.84	33	2.12	37	5.64	1.09	19	0.25	5	4.39	76	5.76	0.65	1.15	0.26	4.03	0.580	3.96	2.357	C mc
2751	33.04	0.97	34.01	56	14.3	24	12.34	20	60.65	32.9	53	23.35	38	5.46	9	61.71	0.97	0.86	0.71	0.17	0.612	26.64	0.783	ABnc
2752	7.74	0.33	8.07	35	8.05	35	6.74	30	22.86	7.61	33	6.44	28	8.9	39	22.95	0.94	0.84	0.85	1.17	0.667	14.79	1.833	CAc
RANKEN 1:250,000 SHEET AREA																								
83	4.91	0.16	5.07	41	4.02	32	3.4	27	12.49	5.35	43	3.29	27	3.64	30	12.28	1.06	0.85	0.61	0.68	0.585	7.42	1.464	ACnc
84	1.87	0.16	2.03	24	3.49	41	2.93	35	8.45	2.32	28	2.65	31	3.43	41	8.40	1.14	0.84	1.14	1.48	0.596	6.42	3.163	~~CAc~~ CB
96	2.7	0.18	2.88	25	4.65	39	4.23	36	11.76	3.83	33	3.92	34	3.91	33	11.66	1.33	0.91	1.02	1.02	0.549	8.88	3.083	~~CBc~~ BC
392	5.39	0.17	5.56	35	5.93	37	4.4	28	15.89	6.21	40	5.57	35	3.96	25	15.74	1.12	0.74	0.90	0.64	0.622	10.33	1.858	ABcn
495	16.74	0.62	17.36	53	7.5	23	7.77	24	32.63	16.34	50	12.33	37	4.26	13	32.93	0.94	1.04	0.75	0.26	0.635	15.27	0.880	~~Anm~~ AB
533	1.03	0.13	1.16	16	3.40	47	2.67	37	7.23	0.84	12	0.88	12	5.32	76	7.04	0.72	0.79	1.05	6.33	0.583	6.07	5.233	Cc
534	1.7	0.17	1.87	23	3.14	39	3.08	38	8.09	1.80	23	1.54	20	4.54	57	7.88	0.96	0.98	0.86	2.52	-	6.22	3.326	~~CAcm~~ C
536	3.48	0.44	3.92	32	4.60	37	3.87	31	12.39	4.79	40	3.56	30	3.62	30	11.97	1.22	0.84	0.74	0.76	0.568	8.47	2.161	ACc
537	10.13	0.2	10.33	45	6.6	29	6.09	26	23.02	13.76	61	4.47	20	4.41	19	22.64	1.33	0.92	0.32	0.32	0.556	12.69	1.228	Anc
542	8.65	0.39	9.04	39	7.22	31	6.83	30	23.09	12.08	53	4.52	20	6.25	27	22.85	1.34	0.95	0.37	0.52	0.559	14.05	1.554	~~ACnc~~ A
545	8.26	0.17	8.43	39	6.95	32	6.09	29	21.47	10.9	52	6.44	30	3.85	18	21.19	1.29	0.88	0.59	0.35	0.584	13.04	1.547	Anc
735	1.3	0.02	1.32	19	3.0	43	2.63	38	6.95	0.99	14	1.37	20	4.59	66	6.95	0.75	0.88	1.38	4.64	0.575	5.63	4.265	Cc
737	4.11	0.13	4.24	37	3.97	34	3.41	29	11.62	3.49	31	2.78	25	4.98	44	11.25	0.82	0.86	0.80	1.43	0.578	7.38	1.741	CAnc
738	2.05	0.08	2.13	20	5.15	47	3.66	33	10.93	2.9	33	0.78	7	6.97	60	10.65	1.36	0.71	0.27	2.40	0.515	8.81	4.136	Cc
744	10.65	0.38	11.03	56	4.5	23	4.11	21	19.64	8.45	44	7.08	36	3.93	20	19.46	0.77	0.91	0.84	0.47	0.699	8.61	0.781	ABnc

Reg.	Na	K	Na+K		Ca		Mg		Sc	Cl		SO_4		HCO_3		Sa	Cl	Mg	SO_4	HCO_3	T.D.S.	Ca+Mg	Ca+Mg	
No.	epm.	epm.	epm.	5%	epm.	%	epm.	%	epm.	epm.	%	epm	%	epm.	%	epm.	Na+K	Ca	Cl	Cl	S.C.	epm.	Na+K	TYPE
747	1.39	0.03	1.42	18	3.6	46	2.8	36	7.82	1.41	18	0.94	12	5.41	70	7.76	1.00	0.78	0.67	3.84	0.622	6.4	4.254	Cc
751	0.88	0.1	0.98	15	2.66	42	2.77	43	6.41	0.53	8	0.62	10	5.23	82	6.38	0.54	1.04	1.17	9.87	0.562	5.43	5.541	Cm
752	26.09	0.92	27.01	65	8.6	21	5.67	14	41.28	23.1	56	13.54	33	4.59	11	41.23	0.86	0.66	0.59	0.20	0.706	14.27	0.528	Anc
756	3.75	0.16	3.91	24	6.45	40	5.9	36	16.26	6.11	37	3.4	21	6.92	42	16.43	1.56	0.91	0.56	1.13	0.630	12.35	7.841	CAc
758	1.57	0.02	1.59	21	3.0	40	2.88	39	7.47	1.13	15	2.71	37	3.61	48	7.45	0.71	0.96	2.40	3.19	0.767	5.88	3.159	CBc
932	19.39	0.54	19.93	59	7.63	22	6.39	19	33.95	16.48	48	13.10	38	4.57	14	34.15	0.83	0.84	0.79	0.28	0.642	14.02	0.703	ABnc
941	2.14	0.13	2.27	23	3.98	41	3.5	36	9.75	3.72	38	1.96	20	4.18	42	9.86	1.64	0.88	0.53	1.12	0.571	7.48	3.295	CAc
944	3.54	0.12	3.66	34	3.64	34	3.33	32	10.63	4.51	44	1.98	19	3.84	37	10.33	1.23	0.91	0.44	0.85	0.535	6.97	1.904	ACc
949	2.68	0.12	2.80	28	3.66	38	3.3	34	9.76	3.46	36	2.56	26	3.74	38	9.76	1.24	0.90	0.74	1.08	0.587	6.96	2.486	CAc
951	3.2	0.16	3.36	32	3.75	35	3.46	33	10.57	4.08	40	2.39	23	3.81	37	10.28	1.21	0.92	0.59	0.93	0.578	7.21	2.146	ACc
1148	7.91	0.56	8.47	39	6.45	30	6.59	31	21.51	10.04	47	4.23	20	7.07	33	21.34	1.19	1.02	0.42	0.70	0.594	13.04	1.540	ACnc
1150	2.04	0.04	2.08	24	3.5	40	3.21	36	8.79	1.97	22	2.79	32	4.1	46	8.86	0.95	0.92	1.42	2.08	0.482	6.71	3.226	CBc
1151	1.24	0.16	1.40	20	3.18	44	2.56	36	7.14	1.27	18	1.42	21	4.26	61	6.95	0.91	0.81	1.12	3.35	0.597	5.74	4.100	Cc
1152	1.28	0.14	1.42	18	3.39	44	2.94	38	7.75	1.19	16	1.8	23	4.64	61	7.63	0.84	0.87	1.51	3.90	0.637	6.33	4.458	Cc
1153	1.91	0.12	2.03	19	4.25	40	4.33	41	10.61	2.42	24	1.59	15	6.22	61	10.23	1.19	1.02	0.66	2.57	0.542	8.58	4.227	Cm
1154	1.38	0.09	1.47	19	3.23	42	3.01	39	7.71	1.30	18	0.92	12	5.27	70	7.49	0.88	0.93	0.71	4.05	0.516	6.24	4.245	Cc
1155	2.61	0.10	2.71	23	4.12	35	4.82	42	11.65	4.21	37	1.08	10	6.07	53	11.36	1.55	1.17	0.26	1.44	0.523	8.94	3.299	CAmc
1156	1.01	0.15	1.16	15	3.59	44	3.32	41	8.07	0.72	9	0.84	11	6.41	80	7.97	0.62	0.92	1.17	8.90	0.653	6.91	5.957	Cc
2486	3.48	0.16	3.64	21	6.2	35	7.73	44	17.57	3.58	20	8.29	47	5.67	33	17.54	0.98	1.25	2.32	1.58	-	13.93	3.827	BCm
2769	16.3	0.38	16.68	47	9.0	25	9.79	28	35.52	22.54	64	8.54	24	4.1	12	35.18	1.35	1.09	0.38	0.18	0.731	18.79	1.126	Anm
3125	2.78	0.02	2.80	24	3.6	31	5.1	45	11.5	2.68	23	2.92	25	5.9	52	11.5	0.96	1.42	1.09	2.20	0.639	8.7	3.107	~~CBm~~ C
3126	1.09	0.04	1.13	14	3.6	43	3.62	43	8.35	1.69	20	2.92	35	3.77	45	8.38	1.50	1.01	1.73	2.23	0.758	7.22	6.389	CBc
3133	1.23	0.13	1.36	16	3.99	48	3.04	36	8.39	1.36	17	1.78	22	4.97	61	8.11	1.00	0.76	1.31	3.65	0.526	7.03	5.169	Cc
3135	1.74	0.04	1.78	22	3.5	42	2.96	36	8.24	1.97	24	2.71	33	3.61	43	8.29	1.11	0.85	1.38	1.83	0.665	6.46	3.629	CBc
3136	0.27	0.04	0.31	48	0.14	22	0.19	30	0.64	0.20	35	0.03	5	0.35	60	0.58	0.67	1.36	0.15	1.75	0.417	0.33	1.065	Cnm
3137	1.00	0.12	1.12	16	3.25	46	2.72	38	7.09	0.68	10	0.80	12	5.42	78	6.90	0.61	0.84	1.18	7.97	0.529	5.97	5.330	Cc
3156	2.93	0.14	3.07	30	3.84	37	3.33	33	10.24	4.56	44	2.00	20	3.69	36	10.25	1.49	0.87	0.44	0.81	0.552	7.17	2.336	ACc
3157	1.65	0.12	1.77	23	3.1	39	3.05	38	7.92	2.77	36	1.66	21	3.38	43	7.81	1.56	0.98	0.60	1.22	0.524	6.15	3.475	CAc
3159	2.38	0.16	2.54	27	3.81	40	3.17	33	9.52	2.98	32	2.56	27	3.86	41	9.40	1.17	0.83	0.86	1.30	0.587	6.98	2.748	CAc
3162	7.41	0.38	7.79	39	6.27	32	5.85	29	19.91	9.14	46	4.48	22	6.32	32	19.94	1.17	0.93	0.49	0.69	0.599	12.12	1.556	ACnc
3163	13.83	0.47	14.30	61	4.6	20	4.56	19	23.45	12.06	52	7.25	32	3.66	16	22.97	0.84	0.99	0.60	0.30	0.602	9.16	0.641	Anc

MOUNT DRUMMOND 1:250,000 SHEET AREA

Reg. No.	Na epm.	K. epm.	Na+K epm.	Na+K %	Ca epm.	Ca %	Mg epm.	Mg %	Sc epm	Cl epm.	Cl %	SO_4 epm.	SO_4 %	HCO_3 epm.	HCO_3 %	Sa epm.	$\frac{Cl}{Na+K}$	$\frac{Mg}{Ca}$	$\frac{SO_4}{Cl}$	$\frac{HCO_3}{Cl}$	$\frac{T.D.S.}{S.C.}$	Ca+Mg epm.	$\frac{Ca+Mg}{Na+K}$	TYPE
531	0.69	0.09	0.78	11	3.44	49	2.85	40	7.07	0.54	8	0.69	10	5.62	82	6.85	0.69	0.83	1.28	10.41	0.550	6.29	8.064	Cc
748	1.49	0.16	1.65	18	4.30	46	3.37	36	9.32	1.03	12	0.76	8	7.20	80	8.99	0.62	0.78	0.74	6.99	0.549	7.67	4.648	Cc
749	0.85	0.17	1.02	12	4.12	47	3.66	41	8.80	0.54	6	0.43	5	7.61	89	8.58	0.53	0.89	0.80	14.09	0.569	7.78	7.627	Cc
3128	0.7	0.08	0.78	8	4.78	47	4.53	45	10.09	0.54	6	0.43	4	8.88	90	9.85	0.69	0.95	0.80	16.44	0.509	9.31	11.935	Cc
3129	0.52	0.14	0.66	8	3.99	50	3.32	42	7.97	0.38	5	0.55	7	6.92	88	7.85	0.56	0.83	1.45	18.21	0.658	7.31	11.076	Cc
AVON DOWNS 1:250,000 SHEET AREA																								
92	15.13	-	-	-	4.25	-	-	-	19.38	14.0	72	3.46	18	1.90	10	19.36	-	-	0.25	0.14	-	-	-	An
98	10.39	-	-	-	3.25	-	1.79	-	-	9.0	-	2.96	-	3.47	-	15.43	-	-	0.33	0.39	-	-	-	Anc
331	18.7	-	-	-	5.5	-	-	-	-	26.99	-	2.69	-	1.61	-	31.29	-	-	0.10	0.06	-	-	-	An
340	16.04	-	-	-	8.05	-	-	-	24.07	18.99	79	2.67	11	2.39	10	24.05	-	-	0.14	0.13	-	-	-	An
366	4.4	0.21	4.61	36	4.25	33	3.87	31	12.73	5.7	46	2.89	23	3.76	31	12.35	1.24	0.91	0.51	0.66	0.574	8.12	1.761	ACnc
384	3.13	0.19	3.32	30	4.06	37	3.63	33	11.01	1.57	15	1.05	10	8.07	75	10.69	0.68	0.89	0.67	5.14	0.611	7.69	2.316	Cc
994	12.43	-	-	-	5.15	-	-	-	-	15.49	67	4.23	18	3.49	15	23.21	-	-	0.27	0.23	-	-	-	An
1906	5.96	0.33	6.29	34	5.40	29	6.91	37	18.60	6.62	37	4.08	22	7.43	41	18.13	1.05	1.28	0.62	1.12	-	12.31	1.957	CAmn
1871	6.00	0.44	6.44	37	5.7	32	5.51	31	17.65	7.89	46	2.69	16	6.56	38	17.14	1.23	0.97	0.34	0.83	-	11.21	1.741	~~ACnm~~ AC
41	4.43	1.03	5.46	47	3.0	26	3.21	27	11.67	0.93	8	0.5	4	10.0	88	11.43	0.17	1.07	0.54	10.76	-	6.21	1.137	Cnm
733	26.3	1.05	27.35	55	9.9	20	12.9	25	50.15	31.5	65	10.0	21	6.75	14	48.25	1.15	1.30	0.32	2.14	-	22.8	0.834	Anm
2190	48.26	3.18	51.44	65	11.1	14	16.78	21	79.32	55.44	69	17.08	21	7.84	10	80.36	1.08	1.51	0.31	0.14	-	27.88	0.542	Anm
2194	12.6	1.0	13.6	51	6.2	23	6.83	26	26.63	13.1	50	4.85	19	8.08	31	25.83	0.96	1.10	0.37	0.62	-	13.03	0.958	~~Anm~~ AC
2195	19.43	1.56	20.99	58	5.8	16	9.70	26	36.49	18.87	52	9.21	26	7.84	22	35.92	0.90	1.67	0.49	0.42	-	15.5	0.738	Anm
Wonarah	8.74	1.67	10.41	66	2.5	16	2.87[*]	18	15.78[*]	10.65	67	1.85	12	3.28	21	15.78	1.02	1.15	0.17	0.31	-	5.37	0.516	~~ACnm~~ A

[*] Obtained by balancing.